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# Relativistic many-body calculations of multipole (E1, M1, E2, M2, E3, M3) transition wavelengths and rates between 3l-14l' excited and ground states in nickel-like ions

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October 19, 2004

Atomic Data and Nuclear Data Tables

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Relativistic many-body calculations of multipole (E1, M1, E2, M2,  
E3, M3) transition wavelengths and rates between  $3l^{-1}4l'$  excited  
and ground states in nickel-like ions

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September 29, 2004

**Abstract**

Wavelengths, transition rates, and line strengths are calculated for the 76 possible multipole (E1, M1, E2, M2, E3, M3) transitions between the excited  $3s^23p^63d^94l$ ,  $3s^23p^53d^{10}4l$ , and  $3s3p^63d^{10}4l$  and the ground  $3s^23p^63d^{10}$  states in Ni-like ions with the nuclear charges ranging from  $Z = 30$  to 100. Relativistic many-body perturbation theory (RMBPT), including the Breit interaction, is used to evaluate energies and transition rates for multipole transitions in hole-particle systems. This method is based on relativistic many-body perturbation theory, agrees with MCDF calculations in lowest-order, includes all second-order correlation corrections and includes corrections from negative energy states. The calculations start from a  $1s^22s^22p^63s^23p^63d^{10}$  Dirac-Fock potential. First-order perturbation theory is used to obtain intermediate-coupling coefficients, and second-order RMBPT is used to determine the matrix elements. The contributions from negative-energy states are included in the second-order E1,

M1, E2, M2, E3, and M3 matrix elements. The resulting transition energies and transition rates are compared with experimental values and with results from other recent calculations. As a result, we present wavelengths and transition rates data for the selected transitions that includes the 76 possible multipole (E1, M1, E2, M2, E3, M3) transitions between the excited  $3s^23p^63d^94l$ ,  $3s^23p^53d^{10}4l$ , and  $3s3p^63d^{10}4l$  states and the ground  $3s^23p^63d^{10}$  state in Ni-like ions. Trends of the line strengths for the 76 multipole transitions and oscillator strengths for the 13 E1 transitions as function of  $Z$  are illustrated graphically. The  $Z$  dependence of the energy splitting for all triplet terms of the  $3s^23p^63d^94l$ ,  $3s^23p^53d^{10}4l$ , and  $3s3p^63d^{10}4l$  configurations are shown in the range of  $Z = 30$ –100.

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# INTRODUCTION

Relativistic many-body perturbation theory (RMBPT) was used recently to study atomic characteristics of particle-hole excitations of closed-shell ions [1, 2, 3, 4, 5, 6, 7]. In the first of these studies, energies [1, 2, 3] and oscillator strengths [4] in Ne-like ions were considered by Avgoustoglou *et al.* Reduced matrix elements, oscillator strengths, and transition rates into the ground state for all allowed and forbidden electric- and magnetic-dipole and electric- and magnetic-quadrupole transitions (E1, M1, E2, M2) in Ne-like ions were presented by Safronova *et al* in Ref. [5]. The second-order RMBPT calculations for Ni-like ions was used in Ref. [6, 7] to determine excitation energies and E1, M1, E2, M2 transition rates.

The Ni-isoelectronic sequence has been studied extensively in connection with x-ray lasers [8, 9, 10, 11, 12, 13]. A detailed analysis of 3-4 transitions in the x-ray spectra of Ni-like Gd ( $Z=64$ ) produced in a tokamak was presented by van Goeler *et al.* [14] and in the x-ray spectrum from laser produced plasmas of Ni-like Ba ( $Z=56$ ), La ( $Z=57$ ), and Pr ( $Z=59$ ) was reported by Doron *et al.* [15] and Zigler *et al.* [16]. In particular, ab-initio calculations were performed in Ref. [15] using the relativistic parametric potential computer code (RELAC) [17] to identify  $3d-nf$  ( $n=4$  to 8),  $3p-4s$ , and  $3p-4d$  transitions of Ni-like Ba. Atomic structure calculations for highly ionized tungsten (Rb-like  $W^{37+}$  to Co-like  $W^{47+}$ ) were done by Fournier [18] with using the graphical angular momentum coupling code ANGULAR and RELAC code. The RELAC code was used by Busquet *et al.* [19] to identify x-ray spectral lines emitted by a target of Au ( $Z=79$ ). Zhang *et al.* [20], using the Dirac-Fock-Slater (DFS) code evaluated excitation energies and oscillator strengths for the 33 Ni-like ions with  $60 \leq Z \leq 92$ . Energy levels and radiative rates for allowed transitions among the 107 fine-structure levels for the  $n=4$  excited configurations of Ni-like ions with  $Z=60, 62, 63, 73, 74$  were calculated using the fully relativistic GRASP code [21].

The  $n=3-4$  transitions observed in x-ray spectra of Ni-like ions ( $Ag^{19+}$ – $Pb^{54+}$ ) were investigated



theoretically by Quinet and Biémont [22], where the MCDF approach (Grant's code) was used to calculate wavelengths and oscillator strengths for the  $3d - 4p$ ,  $3d - 4f$ ,  $3p - 4s$ , and  $3p - 4d$  electric-dipole transitions. The relative magnitudes of the electric-multipole (E1, E2, E3) and magnetic-multipole (M1, M2, M3) radiative decay rates calculated by the MCDF approach, were presented by Biémont [23] for the 17 lowest levels of highly ionized nickel-like ions. Observations of electric-quadrupole and magnetic-octupole decay in the x-ray spectrum of highly charged Ni-like ions ( $\text{Th}^{62+}$  and  $\text{U}^{64+}$ ) were reported by Beiersdorfer *et al.* in Ref. [24]. There are fewer papers concerned with the analysis of the  $4s - 4p$  and  $4p - 4d$  transitions in Ni-like ions in Ref. [25, 26].

In the present paper, relativistic many-body perturbation theory (RMBPT) is used to determine the energies of  $3s^2 3p^6 3d^9 4l(J)$ ,  $3s^2 3p^5 3d^{10} 4l(J)$ , and  $3s 3p^6 3d^{10} 4l(J)$  states of Ni-like ions with nuclear charges  $Z=30-100$ . The calculations are carried out to second order in perturbation theory. We consider all possible  $3l$  holes and  $4l$  particles leading to the 56 odd-parity  $3d^{-1} 4p(J)$ ,  $3d^{-1} 4f(J)$ ,  $3p^{-1} 4s(J)$ ,  $3p^{-1} 4d(J)$ ,  $3s^{-1} 4p(J)$ , and  $3s^{-1} 4f(J)$  excited states and the 50 even-parity  $3d^{-1} 4s(J)$ ,  $3d^{-1} 4d(J)$ ,  $3p^{-1} 4p(J)$ ,  $3p^{-1} 4f(J)$ ,  $3s^{-1} 4s(J)$ , and  $3s^{-1} 4d(J)$  excited states in Ni-like ions with  $Z=30$  to 100.

Relativistic MBPT is used to determine line strengths, oscillator strengths, and transition rates for all allowed and forbidden electric-multipole and magnetic-multipole (E1, E2, E3, M1, M2, M3) transitions from  $3s^2 3p^6 3d^9 4l(J)$ ,  $3s^2 3p^5 3d^{10} 4l(J)$ , and  $3s 3p^6 3d^{10} 4l(J)$  excited states into the ground state in Ni-like ions. Retarded E1, E2, and E3 matrix elements are evaluated in both length and velocity forms.

## METHOD

Details of the RMBPT method were presented in Refs. [1, 6] for the calculation of energies of hole-particle states, in Ref. [27] for the calculation of energies of particle-particle states, in Ref. [28] for the

calculation of radiative electric-dipole rates in two-particle states, and in Ref. [5, 7] for calculation of radiative electric-dipole, electric-quadrupole, magnetic-dipole, and magnetic-quadrupole rates in Ne- and Ni-like systems. We will present here only the model space for Ni-like ions without repeating the detailed discussions given in the above mentioned references. The calculations are carried out using basis sets of Dirac-Hartree-Fock (DHF) orbitals. The orbitals used in the present calculation are obtained as linear combinations of B-splines. These B-spline basis orbitals are determined using the method described in Ref. [29]. We use 50 B-splines of order 10 for each single-particle angular momentum state and include all orbitals with orbital angular momentum  $l \leq 9$  in our basis set.

For atoms with one hole in closed shells and one valence electron, the model space is formed from hole-particle states of the type  $a_v^+ a_a |0\rangle$ , where  $|0\rangle$  is the closed-shell

$1s_{1/2}^2 2s_{1/2}^2 2p_{1/2}^2 2p_{3/2}^4 3s_{1/2}^2 3p_{1/2}^2 3p_{3/2}^4 3d_{3/2}^4 3d_{5/2}^6$  ground state. The single-particle indices  $v$  range over states in the valence shell and the single-hole indices  $a$  range over the closed core. For our study of low-lying  $3l^{-1}4l'$  states of Ni-like ions, values of  $a$  are  $3s_{1/2}$ ,  $3p_{1/2}$ ,  $3p_{3/2}$ ,  $3d_{3/2}$ , and  $3d_{5/2}$ , while values of  $v$  are  $4s_{1/2}$ ,  $4p_{1/2}$ ,  $4p_{3/2}$ ,  $4d_{3/2}$ ,  $4d_{5/2}$ ,  $4f_{5/2}$ , and  $4f_{7/2}$ . To obtain an orthonormal model of states, we consider the coupled states  $\Phi_{JM}(av)$  defined by

$$\Phi_{JM}(av) = \sqrt{(2J+1)} \sum_{m_a m_v} (-1)^{j_v - m_v} \begin{pmatrix} j_v & J & j_a \\ -m_v & M & m_a \end{pmatrix} a_{vm_v}^\dagger a_{am_a} |0\rangle. \quad (1)$$

Combining the  $n = 3$  hole orbitals and the  $n = 4$  particle orbitals in nickel, we obtain 56 odd-parity states consisting of 5  $J = 0$  states, 13  $J = 1$  states, 15  $J = 2$  states, 12  $J = 3$  states, 7  $J = 4$  states, 3  $J = 5$  states, and one  $J = 6$  state. Additionally, there are 50 even-parity states consisting of 5  $J = 0$  states, 12  $J = 1$  states, 14  $J = 2$  states, 11  $J = 3$  states, 6  $J = 4$  states, and two  $J = 5$  states. The distribution of the 106 states in the model space is summarized in Table I. In this table, we give both  $j\bar{j}$  and  $LS$  designations for hole-particle states. Instead of using the  $3l_j^{-1}4l'_j$ ,

or  $3l^{-1}4l'$  designations, we use simpler designations  $3l_j4l'_j$  or  $3l4l'$  in this and following tables and throughout the text.

Physical hole-particle states are linear combinations of uncoupled hole-particle states ( $av$ ) in the model space that have fixed values of angular momentum and parity. The first-order expansion coefficient  $C_1^N(av)$  is the  $N$ -th eigenvector of the first-order effective Hamiltonian, and  $E_1^N$  is the corresponding eigenvalue. In the present calculation, both Coulomb and Breit interactions are included in the first-order effective Hamiltonian. The resulting eigenvectors are used to determine the second-order Coulomb and Breit corrections and coupled multipole matrix elements [6, 7].

Usually, either  $LS$  or  $jj$  designations are used to label the resulting eigenvectors rather than simply enumerating with an index  $N$ . The  $LS$  designations for the resulting eigenvectors and eigenvalues and  $jj$  designations for the uncoupled states are used for simplicity in all following figures and tables and the text below.

## **$Z$ -dependence of eigenvectors and eigenvalues in Ni-like ions**

In Figs. 1–6, we illustrate the  $Z$ -dependence of the eigenvectors of the  $3l_j\ 4l'_j\ [J]$  hole-particle states. Strong mixing between states within the odd-parity complex with  $J=1$  was discussed in many papers (see, for example, [6]). We refer to a set of states of the same parity and the same  $J$  as a complex of states. Additionally, we found strong mixing within the odd-parity complex with  $J=2$  and even-parity complex with  $J=1$  and 2. There is much smaller mixing within the odd- and even-parity complex with  $J=3$ .

In Figs. 1–3, we show the dependence of the eigenvectors for the examples of odd-parity states with  $J=1, 2$ , and 3, respectively. The dependence of the eigenvectors for the even-parity states with  $J=1-3$  are shown in Figs. 4–6. The  $J=1$  even-parity complex includes 12 states which are listed in Table I. Using the first-order expansion coefficients  $C^Q(av[J])$  defined previously, we can

present the resulting eigenvectors as

$$\begin{aligned}
\Phi(Q) = & C^Q(3d_{3/2}4s_{1/2}[1])\Phi(3d_{3/2}4s_{1/2}[1]) + \\
& C^Q(3d_{5/2}4d_{3/2}[1])\Phi(3d_{5/2}4d_{3/2}[1]) + C^Q(3d_{5/2}4d_{5/2}[1])\Phi(3d_{5/2}4d_{5/2}[1]) + \\
& C^Q(3d_{3/2}4d_{3/2}[1])\Phi(3d_{3/2}4d_{3/2}[1]) + C^Q(3d_{3/2}4d_{5/2}[1])\Phi(3d_{3/2}4d_{5/2}[1]) + \\
& C^Q(3p_{3/2}4p_{1/2}[1])\Phi(3p_{3/2}4p_{1/2}[1]) + C^Q(3p_{3/2}4p_{3/2}[1])\Phi(3p_{3/2}4p_{3/2}[1]) + \\
& C^Q(3p_{1/2}4p_{1/2}[1])\Phi(3p_{1/2}4p_{1/2}[1]) + C^Q(3p_{1/2}4p_{3/2}[1])\Phi(3p_{1/2}4p_{3/2}[1]) + \\
& C^Q(3p_{3/2}4f_{5/2}[1])\Phi(3p_{3/2}4f_{5/2}[1]) + \\
& C^Q(3s_{1/2}4s_{1/2}[1])\Phi(3s_{1/2}4s_{1/2}[1]) + C^Q(3s_{1/2}4d_{3/2}[1])\Phi(3s_{1/2}4d_{3/2}[1]). \quad (2)
\end{aligned}$$

As a result, the 144  $C^Q(av[J])$  coefficients are needed to describe the 12 eigenvalues. These coefficients are often called mixing coefficients. For simplicity, we plot only two or three curves chosen from the 12 mixing coefficients  $C^Q(3l_j4l'_{j'}[1])$  for the  $Q = 3d4d \ ^3D_1$ ,  $Q = 3d4d \ ^3P_1$ ,  $Q = 3p4p \ ^3D_1$ ,  $Q = 3p4p \ ^1P_1$ ,  $Q = 3p4p \ ^3P_1$ , and  $Q = 3s4s \ ^3S_1$  presented in Fig. 4. These coefficients are chosen to illustrate the mixing of the states; the remaining mixing coefficients give very small contributions to those states. We observe strong mixing even between states with different configurations:  $3d_j4d_{j'}[1] + 3p_j4p_{j'}[1]$ ,  $3p_j4p_{j'}[1] + 3p_j4f_{j'}[1]$ , and  $3p_j4p_{j'}[1] + 3s_j4s_{j'}[1]$ . Strong mixing of states occurs for high- $Z$  ions in the region for  $Z = 80 - 85$ . A similar behavior is seen in Figs. 1, 2, and 5 where the  $Z$ -dependence of eigenvectors for odd-parity complexes with  $J=1, 2$ , and for even-parity complexes with  $J=2$  is shown. It should be noted that the mixing for odd- and even-parity states with  $J = 3$  occurs only inside one configuration but with different  $j$  ( $3d_{5/2}4p_{3/2}[3] + 3d_{3/2}4p_{3/2}[3]$ , for example, shown in Fig. 3, and  $3p_{3/2}4f_{5/2}[3] + 3p_{3/2}4f_{7/2}[3]$ , for example, shown in Fig. 6).

Energies, relative to the ground state, of even- and odd-parity states divided by  $(Z - 21)^2$ , are shown in Figs. 7 and 8. It should be noted that  $Z$  was decreased by 21 to provide better presentation of the energy diagrams. We plot a subset of energy levels to illustrate the  $Z$  dependence, choosing

all singlet terms and one representative example among the triplet terms. As a result, we show 24 levels instead of 50 in Fig. 7, and 28 levels instead of 56 in Fig. 8. As can be seen from Figs. 7 and 8, the  $Z$  dependence of energy levels is very different for the  $3d4l\ ^{1,3}L_J$  (Figs. 7a, 7b, 8a, 8b, and 8c), the  $3p4l\ LSJ$  (Figs. 7c, 7d, 8d, and 8e), and the  $3s4l\ ^{1,3}L_J$  (Figs. 7e, 7f, and 8f) states. For example, the curves describing the energy ( $E/(Z - 21)^2$ ) of  $3dnl\ ^{1,3}L_J$  states increase for small  $Z$  ( $Z = 30 - 40$ ) and become almost constant for high  $Z$ . The curves describing the energy ( $E/(Z - 21)^2$ ) of  $3pnl\ ^{1,3}L_J$  and  $3snl\ ^{1,3}L_J$  states, by contrast, decrease with increasing  $Z$  for small  $Z$  ( $Z = 30 - 50$ ) and become almost constant for high  $Z$ . The values of  $E/(Z - 21)^2$  for the  $3pnl\ LSJ$  states change less than for the  $3s4l\ ^{1,3}L_J$  states (6000 - 9000  $\text{cm}^{-1}$  instead of 7000 - 14000  $\text{cm}^{-1}$ ). The values of  $E/(Z - 21)^2$  for the  $3d4l\ ^{1,3}L_J$  states vary between 1000  $\text{cm}^{-1}$  and 6000  $\text{cm}^{-1}$ .

It should be noted that the  $LS$  designations were chosen based upon small values of the multiplet splitting for low- $Z$  ions. To confirm those  $LS$  designations we obtained the fine structure splitting for the  $3d4s\ ^3D$ ,  $3d4p[\ ^3P, \ ^3D, \ ^3F]$ ,  $3d4d[\ ^3P, \ ^3D, \ ^3F, \ ^3G]$ ,  $3d4f[\ ^3P, \ ^3D, \ ^3F, \ ^3G, \ ^3H]$ ,  $3p4s[\ ^3P]$ ,  $3p4p[\ ^3P, \ ^3D]$ ,  $3p4d[\ ^3P, \ ^3D, \ ^3F]$ ,  $3p4f[\ ^3D, \ ^3F, \ ^3G]$ ,  $3s4p\ ^3P$ , and  $3s4f\ ^3F$  triplets.

Energy differences between levels of odd- and even-parity triplet terms, divided by  $(Z - 21)^2$ , are shown in Figs. 9–10 and Fig. 11, respectively. The energy intervals for the  $3d4p(\ ^3P_2 - \ ^3P_1)$ ,  $3d4p(\ ^3D_3 - \ ^3D_2)$ ,  $3d4p(\ ^3F_3 - \ ^3F_2)$ ,  $3d4f(\ ^3P_2 - \ ^3P_1)$ ,  $3d4f(\ ^3G_4 - \ ^3G_3)$ ,  $3d4f(\ ^3G_5 - \ ^3G_4)$ ,  $3d4f(\ ^3H_5 - \ ^3H_4)$ , and  $3p4s(\ ^3P_1 - \ ^3P_0)$  states are very small and almost do not change with  $Z$  as can be seen from Fig. 9. There is a very sharp variation of the splitting with  $Z$  for the  $3d4f\ ^3D$  term but the energies  $\Delta E/(Z - 21)^2$  change by small values, from -40  $\text{cm}^{-1}$  to 20  $\text{cm}^{-1}$ . The energy intervals vary strongly with the nuclear charge for the  $3d4p(\ ^3P_1 - \ ^3P_0)$ ,  $3d4p(\ ^3D_2 - \ ^3D_1)$ ,  $3d4p(\ ^3F_4 - \ ^3F_3)$ ,  $3d4f(\ ^3P_1 - \ ^3P_0)$ , and  $3d4f(\ ^3H_6 - \ ^3H_4)$  states. A similar behavior of the splitting can be observed in Figs. 10 and 11. Our calculations show that the fine structure of almost all

levels shown in Figs. 9-11 do not follow the Landé rules even for small  $Z$ . The unusual splittings are principally due to changes from  $LS$  to  $jj$  coupling, with mixing from other triplet and singlet states. The different  $J$  states are mixed differently. Further experimental confirmation would be very helpful in verifying the correctness of these sometimes sensitive mixing parameters.

## COMPARISON AND DISCUSSION

In Table II, we compare our results for the excitation energies of the 106 levels oin Ni-like tungsten with theoretical results obtained by different codes: the DFS code by Zhang *et al.* [20], the GRASP code by Aggarwal *et al.* [21], the COWAN code [30], and the RELAC code by Fournier [18]. Labelling of levels with headings 'DFS' are taken from Table IV of Ref. [20], with headings 'GRASP' are taken from Table III of Ref. [21], and with headings 'RELAC' are taken from Tables III and IV of Ref. [18]. The  $LSJ$  labelling is used in data obtained by the RMBPT and the COWAN codes. It should be noted that those two labellings are different for some levels. In the COWAN code, a label for every level was chosen by the maximum value among the eigenvectors. This is sometimes not convenient when two levels have the same label. In present paper, we use the RMBPT code to evaluate energies for the whole isoelectronic sequence. It is known that the crossing of energy levels inside one complex with a fixed  $J$  is forbidden by the Wigner and Neumann theorem (see, for example, in Ref. [31]). As a result, we can use only the numbering of the levels by the ordering of the energies. As was already mentioned, either  $LS$  or  $jj$  designations are used to label the resulting eigenvectors and eigenvalues rather than simply enumerating them with an index  $N$ . We choose the  $LS$  designations here since the  $jj$  designations are used for uncoupled matrix elements. The  $LSJ$  labels are chosen based upon small values of the multiplet splitting for low- $Z$  ions.

We did not repeat the comparison of RMBPT results with experimental data given in our previous paper [6] where excellent agreement was found for high  $Z$  ions ( $Z \geq 47$ ). In the present

paper a new computer code was developed that allowed us to consider not only high- $Z$  ions ( $Z \geq 47$ ), as was done previously [6], but also low- $Z$  ions ( $30 \leq Z \leq 46$ ). We found only very small differences (0.003 - 0.01 % even for  $Z=50$ ) in the wavelengths between our present results and the results in [6]. As can be seen from Table II, the difference between the results from RMBPT and DFS calculations is much larger, 0.06–0.2%. There are no large differences between the results obtained from DFS and GRASP calculations.

In Table III, wavelengths ( $\lambda$  in Å) and oscillator strengths ( $f$ ) for odd-parity states with  $J=1$  are given. We have limited the table to those transitions given in Ref. [20]. A comparison of  $f$  obtained by the RMBPT and DFS codes is given. We use  $LSJ$  labelling for the RMBPT data and use the “M1” – “M15” designations employed in Table I and Table III of Ref. [20] for the DFS data. As can be seen from Table III, the disagreement between our RMBPT oscillator strengths and the DFS results is about 3–10% except in cases with very small values of oscillator strengths. It should be noted that for the  $3p4d\ ^3D_1$  and  $3s4p\ ^3P_1$  states it was difficult to follow the permutation of the labels with  $Z$ , and we are not sure that we found the correct values for comparison with our RMBPT  $f$  values.

## RESULTS

In Table IV, we present our results for wavelengths ( $\lambda$  in Å) and multipole (E1, E2, E3, M1, M2, and M3) transition rates ( $A$  in  $s^{-1}$ ) for the Ni-like ions with nuclear charge  $Z = 36 - 92$ . Level designations are given in three columns for odd-parity states with  $J=1$  (E1 transitions),  $J=2$  (M2 transitions), and  $J=3$  (E3 transitions) and in three columns for even-parity states with  $J=1$  (M1 transitions),  $J=2$  (E2 transitions), and  $J=3$  (M3 transitions). We already mentioned previously that we use  $LSJ$  designations. For each of the 76 multipole transitions we present wavelengths and transition rates.

The general trends of the  $Z$ -dependence of the line strengths for the E1, M2, E3, M1, E2, and M3 transitions are presented in Figs. 12, 13, 14, 15, 16, 17, respectively. The  $Z$ -dependence of the oscillator strengths for E1 transitions are presented in Figs. 18 for Ni-like ions with nuclear charge  $Z = 30 - 100$ .

The E1, E2, E3, M1, M2, and M3 transition probabilities  $A$  ( $\text{s}^{-1}$ ) for the transitions between the excited  $3l4l'$   $LSJ$  states and the ground state are obtained in terms of line strengths  $S$  (a.u.) and wavelength  $\lambda(\text{\AA})$  as

$$\begin{aligned} A(E1) &= \frac{2.02613 \times 10^{18}}{(2J+1)\lambda^3} S(E1), & A(M1) &= \frac{2.69735 \times 10^{13}}{(2J+1)\lambda^3} S(M1) \\ A(E2) &= \frac{1.11995 \times 10^{18}}{(2J+1)\lambda^5} S(E2), & A(M2) &= \frac{1.49097 \times 10^{13}}{(2J+1)\lambda^5} S(M2) \\ A(E3) &= \frac{3.14441 \times 10^{17}}{(2J+1)\lambda^7} S(E3), & A(M3) &= \frac{4.18610 \times 10^{12}}{(2J+1)\lambda^7} S(M3) \end{aligned} \quad (3)$$

Line strengths ( $S$ ) and oscillator strengths ( $f$ ) for the 13 E1 lines from  $3d4p$  [ $^3P_1$ ,  $^3D_1$ ,  $^1P_1$ ],  $3d4f$  [ $^3P_1$ ,  $^3D_1$ ,  $^1P_1$ ],  $3p4s$  [ $^1P_1$ ,  $^3P_1$ ],  $3p4d$  [ $^3P_1$ ,  $^3D_1$ ,  $^1P_1$ ], and  $3s4p$  [ $^3P_1$ ,  $^1P_1$ ] levels to the ground state are plotted in Figs. 12 and 18. The sharp features in the curves shown in these figures can be explained in many cases by strong mixing of states within the odd-parity complex with  $J=1$ . The deep minimum in the curve with the  $3d4p$   $^3P$  label in the  $Z=43-44$  range can be explained by the mixing of the  $3d_{3/2}4p_{1/2}$  [1] and  $3d_{5/2}4p_{3/2}$  [1] states. The double cusp in the curve with the  $3d4f$   $^3P$  label in the interval  $Z=57-59$  is due to mixing of the  $3d_{5/2}4f_{5/2}$  [1] and  $3d_{5/2}4f_{7/2}$  [1] states. The mixing of the  $3d_{5/2}4f_{7/2}$  [1] and  $3d_{3/2}4f_{5/2}$  [1] states in the  $Z=55-56$  range gives a singularity in the curve with the  $3d4f$   $^3D_1$  label. The mixing of the  $3d_{3/2}4f_{5/2}$  [1] and  $3p_{3/2}4s_{1/2}$  [1] states in the  $Z=49-50$  range gives a singularity in the curves with the  $3d4f$   $^1P_1$  and  $3p4s$   $^1P_1$  labels.

Line strengths,  $S$ , for the 15 M2 lines from odd-parity states with  $J=2$ , and for the 12 E3 lines from odd-parity states with  $J=3$  levels to the ground state are plotted in Figs. 13 and 14, respectively. The sharp features in the curves shown in Fig. 13 can be explained in many cases



by strong mixing of the  $3d_j4p_{j'}$  [2] and  $3d_j4f_{j'}$  [2] states within the odd-parity complex with  $J=2$ . The curves describing the  $3d4p$  [ $^3F_3$ ,  $^1F_3$ ,  $^3D_3$ ],  $3d4f$  [ $^3D_3$ ,  $^3F_3$ ], and  $3p4d$  [ $^3F_3$ ,  $^1F_3$ ,  $^3D_3$ ] line strengths in Fig. 14 decrease smoothly with  $Z$  without any sharp features.

Line strengths,  $S$ , for the 12 M1 lines from even parity states with  $J=1$  to the ground state are plotted in Fig. 15. The deep minima in the curve describing the  $3d4d$   $^1P$  line strength for small  $Z$  can be explained by strong mixing between the  $3d_{5/2}4d_{3/2}$  [1] and  $3d_{5/2}4d_{5/2}$ [1] states. As can be seen from graphs in Fig. 15, the number of singularities depends on the hole state; the curves describing  $S$  of the  $3d4s$   $^3D_1$  and  $3d4d$   $LSJ$  states are more smooth than the curves describing  $S$  of  $3p4p$   $LSJ$ , and  $3p4f$   $LSJ$ . The largest number of singularities can be observed for the curve describing  $S$  of the  $3s4s$   $^3S_1$ . These singularities are caused by the contribution of second-order uncoupled matrix elements; the sign of the denominator changes with  $Z$  and the denominator becomes very small (see Refs [6, 7] for detail). In this case, the contribution of the term with these small denominators becomes much larger than any other contribution, leading to new singularities in the  $Z$ -dependence of the line strengths. We can remove some of these singularities by increasing our model space to include the  $3d_jnp_{j'}$  and  $3d_jnf_{j'}$  states with  $n=5$  and 6.

Line strengths,  $S$ , for the 14 E2 lines from even-parity states with  $J=2$ , and for the 10 M3 lines from even-parity states with  $J=3$  to the ground state are plotted in Figs. 16 and 17. The curves describing the  $3d4s$  [ $^3D_2$ ,  $^1D_2$ ] line strengths decrease smoothly with  $Z$  without any sharp features. It should be noted that the difference in values of  $S$  for the  $3d4s$   $^3D_2$  and  $3d4s$   $^1D_2$  lines is not large, they even cross each other for  $Z=47-48$ . There is also only a small difference in the values of  $S$  for the  $3d4d$   $^3D_2$ ,  $3d4d$   $^3F_2$ , and  $3d4d$   $^1D_2$  states shown in Fig. 16.

## CONCLUSION

We have presented a systematic second-order relativistic MBPT study of line strengths, oscillator strengths, and transition rates for the  $3l-4l'$  multipole (E1, E2, E3, M1, M2, M3) transitions in Ni-like ions with nuclear charges  $Z$  ranging from 30 to 100. Our retarded multipole matrix elements included correlation corrections from Coulomb and Breit interactions; contributions from negative energy states were also included to insure gauge independence. Both length and velocity forms of the matrix elements were evaluated and small differences, caused by the non locality of the starting HF potential, were found between the two forms. Second-order RMBPT transition energies were used in our evaluation of oscillator strengths and transition rates. These calculations were compared with other calculations. For  $Z \geq 36$ , we believe that the present theoretical data are more accurate than other theoretical data for transitions between  $n = 4$  states and the ground state in Ni-like ions. We hope that these results will be useful in analyzing older experiments and in planning new ones involving Ni-like ions. Additionally, these calculations provide basic theoretical input amplitudes for calculations of multipole matrix elements, oscillator strengths, and transition rates in core-excited states of Cu-like system.

## Acknowledgments

This work was supported by DOE/NNSA under UNR grant DE-FC52-01NV14050 and Lawrence Livermore National Laboratory under contract No. B520743. Work at the Lawrence Livermore National Laboratory was performed under the auspices of the U.S. Department of Energy under Contract No. W-7405-Eng-48.

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## EXPLANATION OF GRAPHS

GRAPHS 1–6. Mixing coefficients for odd- and even-parity states with  $J=1-3$  as functions of  $Z$ .

The calculated mixing coefficients  $C^Q(3l_j4l'_j, [J])$  for given states are plotted as a function of the nuclear charge  $Z$ . Configurations in  $jj$  and  $LS$  coupling scheme  $3l_j4l'_j$  and  $3l4l'$  and whole momenta  $J$  and  $LSJ$ , respectively, are used as a label for each figure.

GRAPHS 7–8. Energies ( $E/(Z-21)^2$ ) in  $\text{cm}^{-1}$  for even- and odd-parity states as functions of  $Z$ .

The calculated energies  $E$  divided by  $(Z-21)^2$  for given states as included in each figure, are plotted as a function of the nuclear charge  $Z$ . Configurations  $3l4l'$  and whole  $LSJ$  are used as a label for each figure.

Energies divided by  $(Z-21)^2$ ,  $E/(Z-21)^2$ , are plotted in  $\text{cm}^{-1}$  unit.

GRAPHS 9–11. Energy splitting ( $\Delta E/(Z-21)^2$ ) in  $\text{cm}^{-1}$  for terms of even- and odd-parity states as functions of  $Z$ .

The calculated energies between two levels,  $\Delta E$  divided by  $(Z-21)^2$  for given levels as included in figure, are plotted as a function of the nuclear charge  $Z$ . Configurations  $3l4l'$  and whole  $LSJ$  are used as a label for each figure.

Energy differences divided by  $(Z-21)^2$ ,  $\Delta E/(Z-21)^2$ , are plotted in  $\text{cm}^{-1}$  unit.

GRAPHS 12–17. E1, M2, E3, M1, E2, and M3 line strengths between odd- and even-parity states with  $J = 1-3$  and the ground state as function of  $Z$ .

The calculated line strengths  $S$  for given transition is plotted as a function of nuclear charge  $Z$ . Configurations  $3l4l'$  and whole  $LSJ$  are used as a label for each figure.

Line strengths,  $S$  are plotted in atomic unit.

GRAPH 18. Oscillator strengths between odd-parity states with  $J = 1$  and the ground state as

function of  $Z$ .

The calculated oscillator strengths  $f$  for a given transition is plotted as a function of the nuclear charge  $Z$ . Configurations  $3l4l'$  and whole  $LSJ$  are used as a label for each figure.

Oscillator strengths  $f$  are plotted in arbitrary unit.

## EXPLANATION OF TABLES

TABLE I. Comparison of the  $jj$ - and  $LS$ -coupling schemes for hole-particle states in the  $3l_j4l'_{j'}$  and  $3l4l'$   $LSJ$  complexes.

Configurations in  $jj$  and  $LS$  coupling scheme  $3l_j4l'_{j'}$  and  $3l4l'$  with whole momenta  $J$  and  $LSJ$ , respectively, are given in columns.

TABLE II. Energies ( $1000 \text{ cm}^{-1}$ ) of Ni-like tungsten relative to the ground state. Comparison of RMBPT data with theoretical results from the DFS code by Zhang *et al.*, from GRASP by Aggarwal *et al.*, from the COWAN code, and from RELAC by Fournier.

In the columns 1 and 7, we give the configuration and the whole momenta  $LSJ$  for excited states, in the columns 3, 5, and 9, we give the labels of levels used in above mentioned papers .

The rows contain energies in  $1000 \text{ cm}^{-1}$  unit.

TABLE III. Wavelengths ( $\lambda$  in  $\text{\AA}$ ) and oscillator strengths  $f$  of Ni-like ions for odd-parity states with  $J=1$ . Comparison of RMBPT data with theoretical results from the DFS code by Zhang *et al.*.

Configurations  $3l4l'$  and whole momenta  $LSJ$  are given as column headings.

The rows contain the nuclear charge  $Z$ , wavelengths ( $\lambda$  in  $\text{\AA}$ ), and oscillator strengths  $f$  in arbitrary units.

TABLE IV. Wavelengths ( $\lambda$  in  $\text{\AA}$ ) and multipole (E1, E2, E3, M1, M2, and M3) transition rates ( $A$  in  $\text{s}^{-1}$ ) for Ni-like ions with the nuclear charge  $Z=36-92$ .

The following notation is used:  $a[-b]=a^{-b}$ ,  $a[b]=a^{+b}$ , and  $a[00]=a$  to represent powers of ten.

In the first, fourth, and seventh column, we give the configuration and the whole momenta  $LSJ$  for the excited state.

The rows contain the wavelengths in Å and transition rates in  $s^{-1}$ , beginning from  $Z=36$  up to  $Z=92$  for the last page of table.



Table I: A comparison of the  $jj$ - and  $LS$ -coupling schemes for hole-particle states in the  $3l_j4l'_j$  and  $3l4l'$   $LSJ$  complexes

odd-parity states							
$jj$ coupl.	$LS$ coupl.	$jj$ coupl.	$LS$ coupl.	$jj$ coupl.	$LS$ coupl.	$jj$ coupl.	$LS$ coupl.
$3d_{3/2}4p_{3/2}$	$3d4p \ ^3P_0$	$3d_{3/2}4p_{1/2}$	$3d4p \ ^3P_1$	$3d_{5/2}4p_{1/2}$	$3d4p \ ^3F_2$	$3d_{5/2}4p_{1/2}$	$3d4p \ ^3F_3$
$3d_{5/2}4f_{5/2}$	$3d4f \ ^3P_0$	$3d_{5/2}4p_{3/2}$	$3d4p \ ^3D_1$	$3d_{5/2}4p_{3/2}$	$3d4p \ ^3P_2$	$3d_{5/2}4p_{3/2}$	$3d4p \ ^1F_3$
$3p_{1/2}4s_{1/2}$	$3p4s \ ^3P_0$	$3d_{3/2}4p_{3/2}$	$3d4p \ ^1P_1$	$3d_{3/2}4p_{1/2}$	$3d4p \ ^1D_2$	$3d_{3/2}4p_{3/2}$	$3d4p \ ^3D_3$
$3p_{3/2}4d_{3/2}$	$3p4d \ ^3P_0$	$3d_{5/2}4f_{5/2}$	$3d4f \ ^3P_1$	$3d_{3/2}4p_{3/2}$	$3d4p \ ^3D_2$	$3d_{5/2}4f_{5/2}$	$3d4f \ ^3D_3$
$3s_{1/2}4p_{1/2}$	$3s4p \ ^3P_0$	$3d_{5/2}4f_{7/2}$	$3d4f \ ^3D_1$	$3d_{5/2}4f_{5/2}$	$3d4f \ ^3P_2$	$3d_{5/2}4f_{7/2}$	$3d4f \ ^3G_3$
$3d_{5/2}4p_{3/2}$	$3d4p \ ^3F_4$	$3d_{3/2}4f_{5/2}$	$3d4f \ ^1P_1$	$3d_{5/2}4f_{7/2}$	$3d4f \ ^3D_2$	$3d_{3/2}4f_{5/2}$	$3d4f \ ^3F_3$
$3d_{5/2}4f_{5/2}$	$3d4f \ ^3H_4$	$3p_{3/2}4s_{1/2}$	$3p4s \ ^1P_1$	$3d_{3/2}4f_{5/2}$	$3d4f \ ^1D_2$	$3d_{3/2}4f_{7/2}$	$3d4f \ ^1F_3$
$3d_{5/2}4f_{7/2}$	$3d4f \ ^3G_4$	$3p_{1/2}4s_{1/2}$	$3p4s \ ^3P_1$	$3d_{3/2}4f_{7/2}$	$3d4f \ ^3F_2$	$3p_{3/2}4d_{3/2}$	$3p4d \ ^3F_3$
$3d_{3/2}4f_{5/2}$	$3d4f \ ^3F_4$	$3p_{3/2}4d_{3/2}$	$3p4d \ ^3P_1$	$3p_{3/2}4s_{1/2}$	$3p4s \ ^3P_2$	$3p_{3/2}4d_{5/2}$	$3p4d \ ^1F_3$
$3d_{3/2}4f_{7/2}$	$3d4f \ ^1G_4$	$3p_{3/2}4d_{5/2}$	$3p4d \ ^1P_1$	$3p_{3/2}4d_{3/2}$	$3p4d \ ^3F_2$	$3p_{1/2}4d_{5/2}$	$3p4d \ ^3D_3$
$3p_{3/2}4d_{5/2}$	$3p4d \ ^3F_4$	$3p_{1/2}4d_{3/2}$	$3p4d \ ^3D_1$	$3p_{3/2}4d_{5/2}$	$3p4d \ ^3P_2$	$3s_{1/2}4f_{5/2}$	$3s4f \ ^3F_3$
$3s_{1/2}4f_{7/2}$	$3s4f \ ^3F_4$	$3s_{1/2}4p_{1/2}$	$3s4p \ ^3P_1$	$3p_{1/2}4d_{3/2}$	$3p4d \ ^3D_2$	$3s_{1/2}4f_{7/2}$	$3s4f \ ^1F_3$
$3d_{5/2}4f_{5/2}$	$3d4f \ ^3H_5$	$3s_{1/2}4p_{3/2}$	$3s4p \ ^1P_1$	$3p_{1/2}4d_{5/2}$	$3p4d \ ^1D_2$		
$3d_{5/2}4f_{7/2}$	$3d4f \ ^3G_5$			$3s_{1/2}4p_{3/2}$	$3s4p \ ^3P_2$		
$3d_{3/2}4f_{7/2}$	$3d4f \ ^1H_5$			$3s_{1/2}4f_{5/2}$	$3s4f \ ^3F_2$		
$3d_{5/2}4f_{7/2}$	$3d4f \ ^3H_6$						
even-parity states							
$jj$ coupl.	$LS$ coupl.	$jj$ coupl.	$LS$ coupl.	$jj$ coupl.	$LS$ coupl.	$jj$ coupl.	$LS$ coupl.
$3d_{5/2}4d_{5/2}$	$3d4d \ ^3P_0$	$3d_{3/2}4s_{1/2}$	$3d4s \ ^3D_1$	$3d_{5/2}4s_{1/2}$	$3d4s \ ^3D_2$	$3d_{5/2}4s_{1/2}$	$3d4s \ ^3D_3$
$3d_{3/2}4d_{3/2}$	$3d4d \ ^1S_0$	$3d_{5/2}4d_{3/2}$	$3d4d \ ^3S_1$	$3d_{3/2}4s_{1/2}$	$3d4s \ ^1D_2$	$3d_{5/2}4d_{3/2}$	$3d4d \ ^3G_3$
$3p_{3/2}4p_{3/2}$	$3p4p \ ^3P_0$	$3d_{5/2}4d_{5/2}$	$3d4d \ ^1P_1$	$3d_{5/2}4d_{3/2}$	$3d4d \ ^3P_2$	$3d_{5/2}4d_{5/2}$	$3d4d \ ^3D_3$
$3p_{1/2}4p_{1/2}$	$3p4p \ ^1S_0$	$3d_{3/2}4d_{3/2}$	$3d4d \ ^3D_1$	$3d_{5/2}4d_{5/2}$	$3d4d \ ^3D_2$	$3d_{3/2}4d_{3/2}$	$3d4d \ ^3F_3$
$3s_{1/2}4s_{1/2}$	$3s4s \ ^1S_0$	$3d_{3/2}4d_{5/2}$	$3d4d \ ^3P_1$	$3d_{3/2}4d_{3/2}$	$3d4d \ ^3F_2$	$3d_{3/2}4d_{5/2}$	$3d4d \ ^1F_3$
$3d_{5/2}4d_{3/2}$	$3d4d \ ^3G_4$	$3p_{3/2}4p_{1/2}$	$3p4p \ ^3D_1$	$3d_{3/2}4d_{5/2}$	$3d4d \ ^1D_2$	$3p_{3/2}4p_{3/2}$	$3p4p \ ^3D_3$
$3d_{5/2}4d_{5/2}$	$3d4d \ ^1G_4$	$3p_{3/2}4p_{3/2}$	$3p4p \ ^3S_1$	$3p_{3/2}4p_{1/2}$	$3p4p \ ^3D_2$	$3p_{3/2}4f_{5/2}$	$3p4f \ ^3D_3$
$3d_{3/2}4d_{5/2}$	$3d4d \ ^3F_4$	$3p_{1/2}4p_{1/2}$	$3p4p \ ^1P_1$	$3p_{3/2}4p_{3/2}$	$3p4p \ ^1D_2$	$3p_{1/2}4f_{5/2}$	$3p4f \ ^3G_3$
$3p_{3/2}4f_{5/2}$	$3p4f \ ^3G_4$	$3p_{1/2}4p_{3/2}$	$3p4p \ ^3P_1$	$3p_{1/2}4p_{3/2}$	$3p4p \ ^3P_2$	$3p_{3/2}4f_{7/2}$	$3p4f \ ^1F_3$
$3p_{3/2}4f_{7/2}$	$3p4f \ ^1G_4$	$3p_{3/2}4f_{5/2}$	$3p4f \ ^3D_1$	$3p_{3/2}4f_{5/2}$	$3p4f \ ^3D_2$	$3p_{1/2}4f_{7/2}$	$3p4f \ ^3F_3$
$3p_{1/2}4f_{7/2}$	$3p4f \ ^3F_4$	$3s_{1/2}4s_{1/2}$	$3s4s \ ^3S_1$	$3p_{3/2}4f_{7/2}$	$3p4f \ ^1D_2$	$3s_{1/2}4d_{5/2}$	$3s4d \ ^3D_3$
$3d_{5/2}4d_{5/2}$	$3p4f \ ^3G_5$	$3s_{1/2}4d_{3/2}$	$3s4d \ ^3D_1$	$3p_{1/2}4f_{5/2}$	$3p4f \ ^3F_2$		
$3p_{3/2}4f_{7/2}$	$3p4f \ ^3G_5$			$3s_{1/2}4d_{3/2}$	$3s4d \ ^3D_2$		
				$3s_{1/2}4d_{5/2}$	$3s4d \ ^1D_2$		

Table II: Energies ( $1000 \text{ cm}^{-1}$ ) of Ni-like tungsten relative to the ground state. A comparison of RMBPT data with the theoretical results from the DFS code by Zhang *et al.*, from GRASP by Aggarwal *et al.*, from the COWAN code, and RELAC by Fournier

RMBPT		DFS		GRASP		COWAN		RELAC	
Level	Energy	Level	Energy	Level	Energy	Level	Energy	Level	Energy
$3d4d \ ^3P_0$	15728.557	D1	15722.966	27	15722.966	$3d4d \ ^3P_0$	15737.342		
$3d4d \ ^1S_0$	16251.480	D2	16285.134	37	16299.007	$3d4d \ ^1S_0$	16228.741		
$3p4p \ ^1S_0$	18004.497	D3	18044.228	63	18055.520	$3p4p \ ^1S_0$	17950.463		
$3p4p \ ^3P_0$	19587.829	D4	19625.881	75	19636.527	$3p4p \ ^3P_0$	19630.881		
$3s4s \ ^1S_0$	20702.189	D5	20756.670	87	20768.042	$3s4s \ ^1S_0$	20729.097		
$3d4s \ ^3D_1$	13134.128	E1	13117.796	4	13115.457	$3d4s \ ^3D_1$	13171.765		
$3d4d \ ^3S_1$	15365.851	E2	15353.564	18	15353.644	$3d4d \ ^3P_1$	15378.579		
$3d4d \ ^1P_1$	15557.844	E3	15547.137	22	15546.653	$3d4d \ ^1P_1$	15575.692	22	15552.729
$3d4d \ ^3D_1$	15932.465	E4	15922.184	28	15920.733	$3d4d \ ^3D_1$	15956.971	28	15929.084
$3d4d \ ^3P_1$	16096.591	E5	16084.302	31	16082.527	$3d4d \ ^3P_1$	16124.532	31	16088.830
$3p4p \ ^3D_1$	17004.528	E6	17023.937	49	17025.873	$3p4p \ ^3P_1$	16938.158		
$3p4p \ ^3S_1$	17834.220	E7	17849.849	61	17851.784	$3p4p \ ^1P_1$	17800.132		
$3p4p \ ^1P_1$	19476.652	E8	19500.865	74	19501.994	$3p4p \ ^3D_1$	19540.361		
$3p4p \ ^3P_1$	20292.383	E9	20318.711	76	20319.679	$3p4f \ ^3D_1$	20359.697		
$3p4f \ ^3D_1$	20418.051	E10	20433.242	78	20439.533	$3p4p \ ^3P_1$	20389.491		
$3s4s \ ^3S_1$	20651.681	E11	20690.532	86	20692.307	$3s4s \ ^3S_1$	20679.517		
$3s4d \ ^3D_1$	23436.512	E18	23486.049	100	23487.662	$3s4d \ ^3D_1$	23447.233		
$3d4s \ ^3D_2$	12611.518	F1	12597.568	3	12595.713	$3d4s \ ^1D_2$	12634.586	3	12602.000
$3d4s \ ^1D_2$	13143.749	F2	13128.281	5	13125.297	$3d4s \ ^3D_2$	13180.652	5	13135.000
$3d4d \ ^3P_2$	15414.484	F3	15405.990	20	15404.780	$3d4d \ ^3D_2$	15421.413	20	15409.700
$3d4d \ ^3D_2$	15612.332	F4	15602.789	25	15601.337	$3d4d \ ^1D_2$	15620.402	25	15606.138
$3d4d \ ^3F_2$	15980.676	F5	15972.997	30	15970.174	$3d4d \ ^3F_2$	15997.239	30	15978.440
$3d4d \ ^1D_2$	16134.864	F6	16124.630	33	16122.129	$3d4d \ ^3D_2$	16160.029	33	16130.568
$3p4p \ ^3D_2$	17013.593	F7	17032.003	51	17033.616	$3p4p \ ^3D_2$	16945.789	51	17038.873
$3p4p \ ^1D_2$	17874.400	F8	17891.790	62	17892.999	$3p4p \ ^3P_2$	17835.044		
$3p4p \ ^3P_2$	20321.518	F9	20346.134	77	20347.021	$3p4f \ ^3D_2$	20389.744		
$3p4f \ ^3D_2$	20459.700	F10	20473.569	79	20478.651	$3p4p \ ^3D_2$	20422.743		
$3p4f \ ^1D_2$	20583.411	F11	20602.618	85	20607.619	$3p4f \ ^1D_2$	20515.421	87	20612.367
$3p4f \ ^3F_2$	22989.693	F20	23006.149	97	23011.230	$3p4f \ ^3F_2$	23043.120		
$3s4d \ ^3D_2$	23447.744	F21	23462.659	101	23497.905	$3s4d \ ^3D_2$	23457.055		
$3s4d \ ^1D_2$	23626.077	F23	23674.782	103	23660.184	$3s4d \ ^1D_2$	23641.893		
$3d4s \ ^3D_3$	12597.184	G1	12582.244	2	12580.470	$3d4s \ ^3D_3$	12622.062		
$3d4d \ ^3G_3$	15432.033	G2	15425.347	21	15423.653	$3d4d \ ^3F_3$	15437.011	21	15429.274
$3d4d \ ^3D_3$	15601.521	G3	15593.110	24	15591.659	$3d4d \ ^3D_3$	15613.467	24	15507.352
$3d4d \ ^3F_3$	15935.621	G4	15925.411	29	15923.394	$3d4d \ ^3G_3$	15959.482	29	15932.833
$3d4d \ ^1F_3$	16149.426	G5	16139.954	34	16137.534	$3d4d \ ^3F_3$	16173.396	34	16146.419
$3p4p \ ^3D_3$	17833.374	G6	17849.042	60	17850.978	$3p4p \ ^3D_3$	17799.647		
$3p4f \ ^3D_3$	20496.502	G8	20540.513	82	20517.204	$3p4f \ ^3F_3$	20428.488		
$3p4f \ ^3G_3$	20524.452	G9	20600.198	83	20544.788	$3p4f \ ^1F_3$	20465.079	83	20548.319
$3p4f \ ^1F_3$	22953.051	G16	22965.821	96	22969.935	$3p4f \ ^3D_3$	23054.516		
$3p4f \ ^3F_3$	22991.031	G17	23000.503	98	23012.118	$3p4f \ ^3G_3$	23006.661		
$3s4d \ ^3D_3$	23618.686	G20	23667.523	102	23669.056	$3s4d \ ^3D_3$	23636.000		
$3d4d \ ^3G_4$	15402.637	H1	15394.698	19	15393.246	$3d4d \ ^3G_4$	15413.323	19	15400.533
$3d4d \ ^1G_4$	15616.716	H2	15608.435	26	15606.983	$3d4d \ ^3F_4$	15626.687	26	15613.274
$3d4d \ ^3F_4$	16120.667	H3	16110.112	32	16107.611	$3d4d \ ^3G_4$	16149.541	32	16118.174
$3p4f \ ^3G_4$	20465.398	H4	20481.635	80	20485.910	$3p4f \ ^3G_4$	20402.560		

RMBPT		DFS		GRASP		COWAN		RELAC	
Level	Energy	Level	Energy	Level	Energy	Level	Energy	Level	Energy
$3p4f\ ^1G_4$	20555.536	H5	20571.969	84	20575.679	$3p4f\ ^3F_4$	20491.814	84	20579.551
$3p4f\ ^3F_4$	23007.882	H11	23024.700	99	23029.620	$3p4f\ ^3G_4$	23072.325		
$3d4d\ ^3G_5$	15570.550	I1	15560.848	23	15559.558	$3d4d\ ^3G_5$	15588.249	23	15567.274
$3p4f\ ^3G_5$	20492.634	I2	20507.444	81	20511.881	$3p4f\ ^3G_5$	20438.979		
$3d4p\ ^3P_0$	14717.889	L1	14704.288	14	14701.545	$3d4p\ ^3P_0$	14772.514		
$3d4f\ ^3P_0$	16779.552	L2	16766.647	38	16765.437	$3d4f\ ^3P_0$	16795.116		
$3p4s\ ^3P_0$	18690.843	L3	18707.216	64	18709.232	$3p4s\ ^3P_0$	18761.923		
$3p4d\ ^3P_0$	19002.989	L4	19020.159	66	19023.143	$3p4d\ ^3P_0$	18943.981		
$3s4p\ ^3P_0$	21404.220	L5	21455.952	89	21458.372	$3s4p\ ^3P_0$	21418.447		
$3d4p\ ^3P_1$	13938.341	M1	13929.996	9	13926.931	$3d4p\ ^3D_1$	13957.989	9	13935.000
$3d4p\ ^3D_1$	14229.861	M2	14221.162	12	14218.178	$3d4p\ ^1P_1$	14268.176	12	14226.000
$3d4p\ ^1P_1$	14752.785	M3	14741.389	15	14738.244	$3d4p\ ^3P_1$	14804.914	15	14747.944
$3d4f\ ^3P_1$	16248.872	M4	16262.550	36	16264.083	$3p4s\ ^1P_1$	16195.706	36	16269.509
$3d4f\ ^3D_1$	16799.605	M5	16790.843	39	16789.472	$3d4f\ ^3P_1$	16818.047		
$3d4f\ ^1P_1$	17035.063	M6	17027.970	50	17028.373	$3d4f\ ^3D_1$	17039.031	50	17030.891
$3p4s\ ^1P_1$	17576.706	M7	17585.299	59	17589.977	$3d4f\ ^1P_1$	17582.751	59	17595.389
$3p4s\ ^3P_1$	18709.030	M8	18727.380	65	18728.186	$3p4s\ ^3P_1$	18780.962		
$3p4d\ ^3P_1$	19029.747	M9	19047.582	67	19050.566	$3p4d\ ^3P_1$	18965.049		
$3p4d\ ^1P_1$	19225.918	M10	19242.768	72	19245.187	$3p4d\ ^1P_1$	19161.835	72	19251.470
$3p4d\ ^3D_1$	21370.907	M11	21381.749	88	21419.012	$3s4p\ ^3P_1$	21401.533	98	21427.000
$3s4p\ ^3P_1$	21573.778	M14	21603.552	91	21604.681	$3p4d\ ^3D_1$	21612.243		
$3s4p\ ^1P_1$	22262.028	M16	22312.513	95	22316.142	$3s4p\ ^1P_1$	22305.327		
$3d4p\ ^3F_2$	13374.188	N1	13366.215	6	13364.279	$3d4p\ ^3P_2$	13385.167		
$3d4p\ ^3P_2$	13912.280	N2	13902.573	8	13899.347	$3d4p\ ^3F_2$	13936.763		
$3d4p\ ^1D_2$	14221.459	N3	14211.483	11	14209.225	$3d4p\ ^1D_2$	14259.885		
$3d4p\ ^3D_2$	14775.557	N4	14765.586	17	14761.956	$3d4p\ ^3D_2$	14825.852	17	14772.107
$3d4f\ ^3P_2$	16224.541	N5	16154.472	35	16237.950	$3p4s\ ^3P_2$	16173.247		
$3d4f\ ^3D_2$	16841.344	N6	16831.171	41	16829.477	$3d4f\ ^3D_2$	16852.328		
$3d4f\ ^1D_2$	16882.112	N7	16871.499	45	16869.724	$3d4f\ ^1D_2$	16897.701	45	16873.777
$3d4f\ ^3F_2$	17381.189	N8	17369.949	53	17367.449	$3d4f\ ^1D_2$	17406.490	53	17374.486
$3p4s\ ^3P_2$	17409.206	N9	17397.372	54	17394.791	$3d4f\ ^3D_2$	17437.007		
$3p4d\ ^3F_2$	19059.614	N10	19079.037	69	19081.538	$3p4d\ ^3D_2$	18988.304		
$3p4d\ ^3P_2$	19220.945	N11	19237.928	71	19240.993	$3p4d\ ^1D_2$	19157.339	71	19245.147
$3p4d\ ^3D_2$	21514.851	N15	21560.804	90	21538.947	$3p4d\ ^3F_2$	21589.916		
$3p4d\ ^1D_2$	21684.766	N16	21705.984	92	21708.000	$3p4d\ ^3P_2$	21745.904		
$3s4p\ ^3P_2$	22253.922	N18	22299.608	94	22300.656	$3s4p\ ^3P_2$	22295.107		
$3s4f\ ^3F_2$	24854.861	N24	24904.777	104	24911.149	$3s4f\ ^3F_2$	24876.221		
$3d4p\ ^3F_3$	13383.953	O1	13375.893	7	13373.715	$3d4p\ ^3F_3$	13393.897		
$3d4p\ ^1F_3$	14246.043	O2	14238.099	13	14234.954	$3d4p\ ^3D_3$	14282.415		
$3d4p\ ^3D_3$	14755.494	O3	14743.809	16	14740.179	$3d4p\ ^3F_3$	14808.009	16	14751.357
$3d4f\ ^3D_3$	16866.251	O4	16857.787	42	16855.851	$3d4f\ ^3F_3$	16874.769		
$3d4f\ ^3G_3$	16931.920	O5	16921.505	48	16920.940	$3d4f\ ^1F_3$	16941.597	48	16925.047
$3d4f\ ^3F_3$	17426.419	O6	17417.536	55	17414.390	$3d4f\ ^3G_3$	17444.657	56	17421.897
$3d4f\ ^1F_3$	17451.629	O7	17440.926	57	17438.103	$3d4f\ ^3F_3$	17477.988		
$3p4d\ ^3F_3$	19034.823	O8	19053.227	68	19056.454	$3p4d\ ^3F_3$	18968.228		
$3p4d\ ^1F_3$	19246.376	O9	19264.545	73	19266.803	$3p4d\ ^3D_3$	19179.626	73	19271.673
$3p4d\ ^3D_3$	21714.280	O12	21718.082	93	21724.051	$3p4d\ ^3F_3$	21759.093		
$3s4f\ ^3F_3$	24868.569	O18	24915.263	105	24921.150	$3s4f\ ^3F_3$	24887.206		

RMBPT		DFS		GRASP		COWAN		RELAC	
Level	Energy	Level	Energy	Level	Energy	Level	Energy	Level	Energy
$3s4f\ ^1F_3$	24937.504	O19	24988.659	107	24993.579	$3s4f\ ^1F_3$	24959.612		
$3d4p\ ^3F_4$	14205.760	P1	14195.352	10	14193.255	$3d4p\ ^3F_4$	14247.577		
$3d4f\ ^3H_4$	16875.085	P2	16866.659	44	16865.127	$3d4f\ ^3G_4$	16882.020		
$3d4f\ ^3G_4$	16914.178	P3	16904.567	46	16903.116	$3d4f\ ^3F_4$	16928.397	46	16908.233
$3d4f\ ^3F_4$	17369.516	P4	17357.851	52	17355.754	$3d4f\ ^3H_4$	17395.314		
$3d4f\ ^1G_4$	17461.811	P5	17451.411	58	17448.911	$3d4f\ ^3G_4$	17487.909		
$3p4d\ ^3F_4$	19204.504	P6	19221.797	70	19208.731	$3p4d\ ^3F_4$	19144.643		
$3s4f\ ^3F_4$	24902.344	P12	24949.944	106	24955.994	$3s4f\ ^3F_4$	24928.853		
$3d4f\ ^3H_5$	16834.540	Q1	16824.718	40	16823.428	$3d4f\ ^3H_5$	16849.105	40	16831.116
$3d4f\ ^3G_5$	16926.187	Q2	16917.472	47	16915.375	$3d4f\ ^3G_5$	16939.166	47	16920.970
$3d4f\ ^1H_5$	17426.359	Q3	17414.310	56	17412.132	$3d4f\ ^3H_5$	17457.148		
$3d4f\ ^3H_6$	16869.419	R1	16857.787	43	16856.739	$3d4f\ ^3H_6$	16891.041	43	16864.108

Table III: Wavelengths ( $\lambda$  in  $\text{\AA}$ ) and oscillator strengths ( $f$ ) for Ni-like ions for odd-parity states with  $J=1$ . A comparison of RMBPT data with theoretical results from the DFS code by Zhang *et al.*

$Z$	RMBPT		DFS	RMBPT		DFS	RMBPT		DFS
	$\lambda$	$f$	$f$	$\lambda$	$f$	$f$	$\lambda$	$f$	$f$
	$3d4p$	$^3P_1$	M1	$3d4p$	$^3D_1$	M2	$3d4p$	$^1P_1$	M3
60	13.312	0.1036	0.0962	13.166	0.3376	0.3093	12.863	0.0414	0.0389
61	12.638	0.1113	0.1014	12.493	0.3320	0.3039	12.195	0.0393	0.0376
62	12.015	0.1175	0.1062	11.871	0.3226	0.2987	11.579	0.0396	0.0364
63	11.439	0.1218	0.1107	11.296	0.3179	0.2940	11.008	0.0383	0.0353
64	10.904	0.1257	0.1148	10.761	0.3135	0.2897	10.479	0.0370	0.0343
65	10.408	0.1291	0.1187	10.265	0.3095	0.2830	9.986	0.0359	0.0334
66	9.946	0.1312	0.1223	9.803	0.3069	0.2822	9.528	0.0303	0.0325
67	9.515	0.1352	0.1237	9.372	0.3018	0.2789	9.102	0.0255	0.0316
68	9.112	0.1397	0.1289	8.969	0.2963	0.2760	8.702	0.0340	0.0308
69	8.736	0.1421	0.1319	8.592	0.2935	0.2733	8.329	0.0328	0.0301
70	8.383	0.1444	0.1348	8.239	0.2913	0.2708	7.978	0.0321	0.0294
71	8.053	0.1473	0.1376	7.908	0.2897	0.2686	7.650	0.0313	0.0287
72	7.742	0.1496	0.1402	7.596	0.2855	0.2667	7.342	0.0305	0.0280
73	7.450	0.1520	0.1429	7.303	0.2830	0.2649	7.052	0.0300	0.0274
74	7.174	0.1544	0.1453	7.027	0.2820	0.2633	6.778	0.0293	0.0268
75	6.915	0.1566	0.1478	6.767	0.2801	0.2609	6.521	0.0287	0.0262
76	6.670	0.1589	0.1502	6.521	0.2792	0.2606	6.277	0.0280	0.0256
77	6.439	0.1611	0.1526	6.289	0.2775	0.2595	6.047	0.0275	0.0251
78	6.220	0.1634	0.1530	6.069	0.2766	0.2586	5.829	0.0267	0.0245
79	6.013	0.1659	0.1573	5.861	0.2750	0.2578	5.623	0.0263	0.0239
80	5.817	0.1674	0.1597	5.663	0.2740	0.2572	5.427	0.0257	0.0233
81	5.631	0.1669	0.1620	5.476	0.2751	0.2567	5.241	0.0246	0.0227
82	5.455	0.1673	0.1644	5.298	0.2777	0.2563	5.064	0.0238	0.0221
83	5.287	0.1735	0.1668	5.128	0.2744	0.2561	4.897	0.0226	0.0214
84	5.127	0.1762	0.1693	4.967	0.2730	0.2561	4.737	0.0224	0.0207
85	4.975	0.1781	0.1718	4.813	0.2730	0.2561	4.586	0.0216	0.0200
86	4.831	0.1805	0.1743	4.667	0.2723	0.2564	4.441	0.0208	0.0191
87	4.693	0.1833	0.1769	4.527	0.2728	0.2568	4.303	0.0197	0.0181
88	4.562	0.1863	0.1793	4.394	0.2727	0.2573	4.171	0.0185	0.0169
89	4.437	0.1886	0.1822	4.266	0.2734	0.2581	4.045	0.0170	0.0155
90	4.318	0.1912	0.1830	4.145	0.2743	0.2590	3.924	0.0149	0.0137
91	4.204	0.1940	0.1878	4.028	0.2751	0.2601	3.809	0.0127	0.0112
92	4.095	0.1968	0.1907	3.917	0.2760	0.2615	3.699	0.0092	0.0079
$Z$	RMBPT		DFS	RMBPT		DFS	RMBPT		DFS
	$\lambda$	$f$	$f$	$\lambda$	$f$	$f$	$\lambda$	$f$	$f$
	$3d4f$	$^3P_1$	M4	$3d4f$	$^3D_1$	M5	$3d4f$	$^1P_1$	M6
60	10.783	0.4471	0.3909	10.711	0.0237	0.0332	10.585	0.7408	0.7657
61	10.295	0.4014	0.3913	10.203	0.0183	0.0230	10.082	0.8046	0.8334
62	9.840	0.3989	0.3879	9.731	0.0163	0.0186	9.613	0.8811	0.9035
63	9.415	0.3935	0.3840	9.291	0.0140	0.0160	9.177	0.9469	0.9762
64	9.018	0.3914	0.3805	8.881	0.0123	0.0141	8.771	1.0172	1.0514
65	8.646	0.3866	0.3774	8.499	0.0109	0.0127	8.392	1.0896	1.1290
66	8.298	0.3809	0.3749	8.141	0.0095	0.0114	8.037	1.1562	1.2088
67	7.971	0.3629	0.3727	7.797	0.0045	0.0103	7.714	1.1321	1.2907
68	7.663	0.3803	0.3710	7.491	0.0084	0.0093	7.393	1.3299	1.3744
69	7.374	0.3791	0.3697	7.195	0.0075	0.0084	7.100	1.4079	1.4397
70	7.102	0.3788	0.3688	6.916	0.0066	0.0073	6.825	1.4916	1.5463

$Z$	RMBPT		DFS	RMBPT		DFS	RMBPT		DFS
	$\lambda$	$f$	$f$	$\lambda$	$f$	$f$	$\lambda$	$f$	$f$
	$3d4f$	$^3P_1$	M4	$3d4f$	$^3D_1$	M5	$3d4f$	$^1P_1$	M6
71	6.844	0.3771	0.3681	6.654	0.0059	0.0067	6.565	1.5721	1.6339
72	6.601	0.3763	0.3678	6.407	0.0052	0.0059	6.320	1.6563	1.7222
73	6.372	0.3762	0.3678	6.173	0.0045	0.0052	6.089	1.7342	1.8110
74	6.154	0.3764	0.3681	5.953	0.0038	0.0045	5.870	1.8287	1.9001
75	5.948	0.3771	0.3686	5.743	0.0032	0.0038	5.663	1.9039	1.9890
76	5.753	0.3781	0.3694	5.545	0.0027	0.0032	5.467	1.9895	2.0777
77	5.568	0.3779	0.3704	5.358	0.0022	0.0026	5.281	2.0822	2.1658
78	5.392	0.3805	0.3717	5.179	0.0017	0.0021	5.105	2.1684	2.2531
79	5.225	0.3831	0.3733	5.010	0.0013	0.0016	4.937	2.2473	2.3394
80	5.066	0.3867	0.3750	4.848	0.0009	0.0012	4.778	2.3410	2.4246
81	4.915	0.4074	0.3771	4.695	0.0003	0.0008	4.626	2.3869	2.5085
82	4.772	0.4005	0.3793	4.549	0.0030	0.0005	4.482	2.4575	2.5909
83	4.634	0.3940	0.3819	4.410	0.0001	0.0003	4.344	2.5546	2.6771
84	4.503	0.3921	0.3846	4.277	0.0001	0.0001	4.212	2.6331	2.7508
85	4.378	0.3940	0.3877	4.150	0.0000	0.0000	4.087	2.7120	2.8281
86	4.258	0.3963	0.3910	4.028	0.0000	0.0000	3.967	2.7887	2.9033
87	4.144	0.4001	0.3947	3.912	0.0001	0.0000	3.852	2.8562	2.9770
88	4.035	0.4035	0.3987	3.801	0.0002	0.0002	3.742	2.9285	3.0486
89	3.931	0.4080	0.4031	3.695	0.0005	0.0004	3.637	2.9925	3.1181
90	3.831	0.4126	0.4081	3.593	0.0008	0.0006	3.536	3.0592	3.1836
91	3.735	0.4179	0.4138	3.495	0.0011	0.0010	3.440	3.1295	3.2511
92	3.644	0.4246	0.4206	3.401	0.0016	0.0014	3.347	3.1893	3.3146

$Z$	RMBPT		DFS	RMBPT		DFS	RMBPT		DFS
	$\lambda$	$f$	$f$	$\lambda$	$f$	$f$	$\lambda$	$f$	$f$
	$3p4s$	$^1P_1$	M7	$3p4s$	$^3P_1$	M8	$3p4d$	$^3P_1$	M9
60	10.309	5.5446	6.0861	9.860	0.0573	0.0444	9.183	0.0058	0.0048
61	9.816	5.4603	6.1110	9.384	0.0578	0.0447	8.774	0.0091	0.0071
62	9.358	5.5535	6.1264	8.941	0.0586	0.0451	8.393	0.0111	0.0098
63	8.931	5.5605	6.1333	8.527	0.0569	0.0458	8.036	0.0149	0.0127
64	8.534	5.5684	6.1322	8.140	0.0566	0.0457	7.701	0.0187	0.0161
65	8.163	5.5743	6.1238	7.777	0.0558	0.0478	7.386	0.0231	0.0197
66	7.815	5.5487	6.1088	7.438	0.0577	0.0489	7.091	0.0305	0.0235
67	7.496	5.5598	6.0877	7.120	0.0597	0.0503	6.816	0.0311	0.0276
68	7.184	5.5941	6.0611	6.819	0.0625	0.0517	6.551	0.0307	0.0320
69	6.897	5.5625	6.0295	6.536	0.0682	0.0532	6.304	0.0365	0.0365
70	6.626	5.5487	5.9935	6.270	0.0668	0.0548	6.071	0.0423	0.0413
71	6.372	5.5149	5.9536	6.019	0.0689	0.0565	5.850	0.0459	0.0464
72	6.131	5.4775	5.9101	5.781	0.0702	0.0582	5.641	0.0517	0.0519
73	5.904	5.4400	5.8637	5.557	0.0717	0.0599	5.443	0.0578	0.0580
74	5.689	5.4149	5.8147	5.345	0.0730	0.0615	5.255	0.0648	0.0649
75	5.486	5.3738	5.7637	5.144	0.0739	0.0626	5.076	0.0738	0.0734
76	5.293	5.3299	5.7107	4.953	0.0726	0.0619	4.907	0.0871	0.0857
77	5.110	5.2849	5.6564	4.772	0.0631	0.0553	4.745	0.1124	0.1070
78	4.937	5.2510	5.6010	4.603	0.0214	0.0226	4.589	0.1771	0.1604
79	4.772	5.2131	5.5448	4.450	0.0310	0.0069	4.431	0.2322	0.2100
80	4.615	5.1823	5.4882	4.309	0.0332	0.0336	4.277	0.3069	0.2562
81	4.465	5.1019	5.4313	4.175	0.0784	0.0490	4.130	0.5846	0.5156
82	4.323	5.0515	5.3745	4.040	0.0741	0.0588	3.997	1.0275	1.2559
83	4.187	5.0068	5.3178	3.927	0.0728	0.0661	3.875	1.2831	1.3344

$Z$	RMBPT		DFS	RMBPT		DFS	RMBPT		DFS
	$\lambda$	$f$	$f$	$\lambda$	$f$	$f$	$\lambda$	$f$	$f$
	$3p4s$	$^1P_1$	M7	$3p4s$	$^3P_1$	M8	$3p4d$	$^3P_1$	M9
84	4.057	4.9524	5.2615	3.811	0.0732	0.0720	3.759	1.2774	1.3260
85	3.933	4.9117	5.2037	3.700	0.0770	0.0770	3.648	1.2749	1.3183
86	3.815	4.8636	5.1505	3.594	0.0808	0.0814	3.542	1.2696	1.3136
87	3.702	4.8201	5.0952	3.492	0.0845	0.0855	3.440	1.2720	1.3110
88	3.593	4.7727	5.0426	3.394	0.0876	0.0892	3.342	1.2709	1.3096
89	3.489	4.7304	4.9901	3.300	0.0911	0.0927	3.249	1.2724	1.3089
90	3.390	4.6983	4.9385	3.210	0.0945	0.0960	3.159	1.2747	1.3086
91	3.294	4.6361	4.8880	3.124	0.0966	0.0991	3.072	1.2733	1.3085
92	3.203	4.6049	4.8385	3.041	0.0990	0.1020	2.990	1.2827	1.3086

$Z$	RMBPT		DFS	RMBPT		DFS	RMBPT		DFS
	$\lambda$	$f$	$f$	$\lambda$	$f$	$f$	$\lambda$	$f$	$f$
	$3p4d$	$^1P_1$	M10	$3p4d$	$^3D_1$	M14+M13	$3s4p$	$^3P_1$	M15+M14
60	9.120	0.9539	1.0109	8.490	0.4474	0.4976	8.305	0.1241	0.0768
61	8.713	0.9765	1.0306	8.091	0.4946	0.5085	7.925	0.1201	0.0686
62	8.332	1.0054	1.0487	7.718	0.5171	0.5191	7.574	0.0764	0.0619
63	7.976	1.0071	1.0453	7.370	0.5228	0.5231	7.244	0.0649	0.0554
64	7.642	1.0165	1.0808	7.043	0.5332	0.4276	6.935	0.0552	0.0486
65	7.328	1.0216	1.0950	6.737	0.5430	0.4632	6.644	0.0465	0.0412
66	7.034	1.0526	1.1083	6.449	0.5518	0.5400	6.369	0.0416	0.0332
67	6.756	1.0839	1.1205	6.179	0.5667	0.5708	6.110	0.0680	0.0252
68	6.495	1.1099	1.1317	5.924	0.5824	0.5959	5.865	0.0908	0.0271
69	6.248	1.1096	1.1420	5.684	0.6030	0.6183	5.631	0.0712	0.0154
70	6.015	1.1147	1.1514	5.461	0.6009	0.5176	5.412	0.0512	0.0128
71	5.795	1.1207	1.1598	5.247	0.5634	0.4084	5.206	0.0440	0.0115
72	5.586	1.1269	1.1671	5.047	0.5579	0.4914	5.006	0.0629	0.0107
73	5.389	1.1337	1.1733	4.858	0.5169	0.4883	4.816	0.0703	0.0616
74	5.201	1.1375	1.1781	4.679	0.4825	0.4519	4.635	0.1159	0.1080
75	5.023	1.1461	1.1813	4.510	0.4483	0.3957	4.463	0.1613	0.1551
76	4.854	1.1445	1.1820	4.349	0.4168	0.4159	4.299	0.1987	0.1967
77	4.693	1.1391	1.1790	4.197	0.3953	0.3228	4.142	0.2292	0.2300
78	4.540	1.1310	1.1695	4.051	0.3890	0.3404	3.993	0.2517	0.2564
79	4.394	1.1115	1.1464	3.913	0.4146	0.3498	3.850	0.2660	0.2774
80	4.254	1.0418	1.0838	3.780	0.5694	0.3381	3.715	0.2793	0.2931
81	4.120	0.6489	0.8188	3.646	0.6696	0.3254	3.584	0.2889	0.3049
82	3.981	0.1304	0.0773	3.520	0.5851	0.3093	3.453	0.2955	0.3136
83	3.849	0.0022	0.0001	3.417	0.8035	0.2613	3.343	0.3016	0.3198
84	3.721	0.0168	0.0108	3.309	0.3910	0.1998	3.231	0.3066	0.3244
85	3.597	0.0279	0.0213	3.204	0.3287	0.2927	3.119	0.3159	0.3269
86	3.479	0.0357	0.0287	3.103	0.2962	0.2263	3.016	0.3154	0.3272
87	3.366	0.0412	0.0341	3.006	0.2800	0.2293	2.916	0.3151	0.3227
88	3.257	0.0453	0.0382	2.913	0.2710	0.2203	2.821	0.3164	0.2966
89	3.153	0.0487	0.0414	2.824	0.2661	0.1707	2.729	0.3155	0.3027
90	3.053	0.0511	0.0439	2.738	0.2755	0.1727	2.641	0.3262	0.3526
91	2.958	0.0539	0.0461	2.655	0.2505	0.2643	2.556	0.3232	0.3617
92	2.866	0.0510	0.0479	2.576	0.2498	0.2567	2.475	0.3196	0.3987

Table IV: Wavelengths (  $\lambda$  in Å ) and multipole (E1, E2, E3, M1, M2, and M3) transition rates (  $A$  in  $\text{s}^{-1}$  ) for Ni-like ions with nuclear charge  $Z=36-92$ . Numbers in brackets represent powers of 10.

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=36$ , odd-parity states								
$3d4p\ ^3P_1$	119.158	7.66[08]	$3d4p\ ^3F_2$	120.753	1.52[02]	$3d4p\ ^3F_3$	119.887	4.00[01]
$3d4p\ ^3D_1$	117.212	8.06[10]	$3d4p\ ^3P_2$	118.864	3.88[00]	$3d4p\ ^1F_3$	117.446	2.94[01]
$3d4p\ ^1P_1$	116.335	1.83[10]	$3d4p\ ^1D_2$	117.635	1.23[02]	$3d4p\ ^3D_3$	116.859	4.62[00]
$3d4f\ ^3P_1$	77.389	2.37[09]	$3d4p\ ^3D_2$	116.106	1.15[01]	$3d4f\ ^3D_3$	77.138	8.59[02]
$3d4f\ ^3D_1$	77.056	1.11[11]	$3d4f\ ^3P_2$	77.344	8.00[03]	$3d4f\ ^3G_3$	77.034	2.30[02]
$3d4f\ ^1P_1$	76.114	5.20[11]	$3d4f\ ^3D_2$	77.179	2.24[03]	$3d4f\ ^3F_3$	76.502	4.61[02]
$3p4s\ ^1P_1$	60.662	1.43[11]	$3d4f\ ^1D_2$	76.757	1.01[02]	$3d4f\ ^1F_3$	76.404	8.94[01]
$3p4s\ ^3P_1$	58.615	4.93[10]	$3d4f\ ^3F_2$	76.551	1.21[03]	$3p4d\ ^3F_3$	48.889	4.86[03]
$3p4d\ ^3P_1$	48.966	2.53[10]	$3p4s\ ^3P_2$	60.858	1.15[03]	$3p4d\ ^1F_3$	48.722	7.98[02]
$3p4d\ ^1P_1$	48.743	1.77[11]	$3p4d\ ^3F_2$	48.875	1.63[03]	$3p4d\ ^3D_3$	46.540	3.04[03]
$3p4d\ ^3D_1$	46.545	8.84[10]	$3p4d\ ^3P_2$	48.769	5.31[02]	$3s4f\ ^3F_3$	34.628	5.07[04]
$3s4p\ ^3P_1$	41.047	3.56[10]	$3p4d\ ^3D_2$	46.599	2.19[01]	$3s4f\ ^1F_3$	34.609	1.90[03]
$3s4p\ ^1P_1$	40.884	1.06[11]	$3p4d\ ^1D_2$	46.566	3.39[02]			
			$3s4p\ ^3P_2$	40.955	7.59[02]			
			$3s4f\ ^3F_2$	34.626	1.08[03]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=36$ , even-parity states								
$3d4s\ ^3D_1$	144.863	3.35[-02]	$3d4s\ ^3D_2$	146.376	1.51[05]	$3d4s\ ^3D_3$	146.934	1.10[-03]
$3d4d\ ^3S_1$	93.190	4.33[02]	$3d4s\ ^1D_2$	144.062	4.02[05]	$3d4d\ ^3G_3$	92.121	1.83[-02]
$3d4d\ ^1P_1$	92.396	4.60[01]	$3d4d\ ^3P_2$	92.254	3.61[03]	$3d4d\ ^3D_3$	91.996	1.40[-02]
$3d4d\ ^3D_1$	91.785	9.59[02]	$3d4d\ ^3D_2$	91.881	2.15[06]	$3d4d\ ^3F_3$	91.530	4.90[-03]
$3d4d\ ^3P_1$	91.448	5.98[01]	$3d4d\ ^3F_2$	91.145	2.28[06]	$3d4d\ ^1F_3$	90.967	5.10[-04]
$3p4p\ ^3D_1$	55.779	1.08[04]	$3d4d\ ^1D_2$	90.950	2.98[06]	$3p4p\ ^3D_3$	55.234	4.24[-01]
$3p4p\ ^3S_1$	55.001	2.93[03]	$3p4p\ ^3D_2$	55.471	1.79[07]	$3p4f\ ^3D_3$	44.162	1.56[00]
$3p4p\ ^1P_1$	53.615	1.85[01]	$3p4p\ ^1D_2$	54.996	1.09[07]	$3p4f\ ^3G_3$	44.142	2.51[-01]
$3p4p\ ^3P_1$	53.317	1.98[04]	$3p4p\ ^3P_2$	53.289	1.41[07]	$3p4f\ ^3F_3$	43.083	3.56[-01]
$3p4f\ ^3D_1$	44.359	2.95[01]	$3p4f\ ^3D_2$	44.179	4.27[07]	$3s4d\ ^3D_3$	37.384	8.58[-01]
$3s4s\ ^3S_1$	43.877	1.86[03]	$3p4f\ ^1D_2$	44.136	1.09[08]			
$3s4d\ ^3D_1$	37.410	1.67[01]	$3p4f\ ^3F_2$	43.025	6.40[07]			
			$3s4d\ ^3D_2$	37.390	1.37[06]			
			$3s4d\ ^1D_2$	37.361	7.58[07]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=37$ , odd-parity states								
$3d4p\ ^3P_1$	100.113	7.62[08]	$3d4p\ ^3F_2$	101.497	2.96[02]	$3d4p\ ^3F_3$	100.818	8.45[01]
$3d4p\ ^3D_1$	98.640	1.14[11]	$3d4p\ ^3P_2$	99.888	8.07[00]	$3d4p\ ^1F_3$	98.788	6.48[01]
$3d4p\ ^1P_1$	97.888	2.59[10]	$3d4p\ ^1D_2$	98.961	2.61[02]	$3d4p\ ^3D_3$	98.248	1.33[01]
$3d4f\ ^3P_1$	66.306	1.72[09]	$3d4p\ ^3D_2$	97.669	2.07[01]	$3d4f\ ^3D_3$	66.051	2.32[03]
$3d4f\ ^3D_1$	65.974	8.89[10]	$3d4f\ ^3P_2$	66.255	1.70[04]	$3d4f\ ^3G_3$	65.963	2.35[02]
$3d4f\ ^1P_1$	65.074	9.19[11]	$3d4f\ ^3D_2$	66.088	6.10[03]	$3d4f\ ^3F_3$	65.479	9.95[02]
$3p4s\ ^1P_1$	53.939	1.92[11]	$3d4f\ ^1D_2$	65.736	1.64[02]	$3d4f\ ^1F_3$	65.402	1.34[02]
$3p4s\ ^3P_1$	52.015	6.31[10]	$3d4f\ ^3F_2$	65.522	2.31[03]	$3p4d\ ^3F_3$	43.584	8.52[03]
$3p4d\ ^3P_1$	43.669	3.67[10]	$3p4s\ ^3P_2$	54.090	1.87[03]	$3p4d\ ^1F_3$	43.430	1.50[03]
$3p4d\ ^1P_1$	43.456	2.79[11]	$3p4d\ ^3F_2$	43.570	5.52[03]	$3p4d\ ^3D_3$	42.210	4.76[03]
$3p4d\ ^3D_1$	42.222	1.39[11]	$3p4d\ ^3P_2$	43.477	1.12[03]	$3s4f\ ^3F_3$	31.206	8.12[04]
$3s4p\ ^3P_1$	37.181	3.28[10]	$3p4d\ ^3D_2$	42.269	6.15[01]	$3s4f\ ^1F_3$	31.192	1.46[02]
$3s4p\ ^1P_1$	36.997	2.45[11]	$3p4d\ ^1D_2$	42.240	8.46[02]			
			$3s4p\ ^3P_2$	37.054	1.79[03]			
			$3s4f\ ^3F_2$	31.205	1.09[01]			



level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=37$ , even-parity states								
$3d4s\ ^3D_1$	119.712	8.54[-02]	$3d4s\ ^3D_2$	120.974	3.69[05]	$3d4s\ ^3D_3$	121.399	5.53[-03]
$3d4d\ ^3S_1$	79.579	8.42[02]	$3d4s\ ^1D_2$	119.131	7.63[05]	$3d4d\ ^3G_3$	78.595	4.56[-02]
$3d4d\ ^1P_1$	78.870	5.57[01]	$3d4d\ ^3P_2$	78.786	1.21[03]	$3d4d\ ^3D_3$	78.486	4.06[-02]
$3d4d\ ^3D_1$	78.279	1.69[03]	$3d4d\ ^3D_2$	78.382	4.02[06]	$3d4d\ ^3F_3$	78.078	1.27[-02]
$3d4d\ ^3P_1$	78.061	1.14[02]	$3d4d\ ^3F_2$	77.732	3.67[06]	$3d4d\ ^1F_3$	77.592	1.09[-03]
$3p4p\ ^3D_1$	49.785	2.07[04]	$3d4d\ ^1D_2$	77.595	5.24[06]	$3p4p\ ^3D_3$	49.260	7.96[-01]
$3p4p\ ^3S_1$	49.192	4.38[03]	$3p4p\ ^3D_2$	49.546	2.48[07]	$3p4f\ ^3D_3$	39.377	4.17[00]
$3p4p\ ^1P_1$	47.913	2.44[01]	$3p4p\ ^1D_2$	49.068	2.47[07]	$3p4f\ ^3G_3$	39.359	7.60[-01]
$3p4p\ ^3P_1$	47.554	2.34[04]	$3p4p\ ^3P_2$	47.520	2.38[07]	$3p4f\ ^3F_3$	38.365	1.45[00]
$3p4f\ ^3D_1$	39.740	1.71[02]	$3p4f\ ^3D_2$	39.392	6.95[07]	$3s4d\ ^3D_3$	33.742	1.57[00]
$3s4s\ ^3S_1$	39.436	4.34[03]	$3p4f\ ^1D_2$	39.345	1.59[08]			
$3s4d\ ^3D_1$	33.769	2.81[01]	$3p4f\ ^3F_2$	38.305	1.77[08]			
			$3s4d\ ^3D_2$	33.751	2.19[06]			
			$3s4d\ ^1D_2$	33.720	1.47[08]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=38$ , odd-parity states								
$3d4p\ ^3P_1$	85.560	6.66[08]	$3d4p\ ^3F_2$	86.723	5.58[02]	$3d4p\ ^3F_3$	86.240	1.66[02]
$3d4p\ ^3D_1$	84.396	1.56[11]	$3d4p\ ^3P_2$	85.427	1.60[01]	$3d4p\ ^1F_3$	84.467	1.30[02]
$3d4p\ ^1P_1$	83.694	3.57[10]	$3d4p\ ^1D_2$	84.669	5.19[02]	$3d4p\ ^3D_3$	83.959	3.46[01]
$3d4f\ ^3P_1$	57.643	7.20[09]	$3d4p\ ^3D_2$	83.502	3.30[01]	$3d4f\ ^3D_3$	57.405	4.41[03]
$3d4f\ ^3D_1$	57.315	1.37[11]	$3d4f\ ^3P_2$	57.590	3.72[04]	$3d4f\ ^3G_3$	57.320	5.71[02]
$3d4f\ ^1P_1$	56.458	1.33[12]	$3d4f\ ^3D_2$	57.437	1.02[04]	$3d4f\ ^3F_3$	56.906	1.78[03]
$3p4s\ ^1P_1$	48.486	2.21[11]	$3d4f\ ^1D_2$	57.119	2.30[02]	$3d4f\ ^1F_3$	56.820	2.57[02]
$3p4s\ ^3P_1$	46.593	8.08[10]	$3d4f\ ^3F_2$	56.952	5.50[03]	$3p4d\ ^3F_3$	39.212	1.46[04]
$3p4d\ ^3P_1$	39.280	5.16[10]	$3p4s\ ^3P_2$	48.616	3.08[03]	$3p4d\ ^1F_3$	39.065	2.91[03]
$3p4d\ ^1P_1$	39.096	4.14[11]	$3p4d\ ^3F_2$	39.196	7.88[03]	$3p4d\ ^3D_3$	37.901	8.62[03]
$3p4d\ ^3D_1$	37.920	2.07[11]	$3p4d\ ^3P_2$	39.113	2.32[03]	$3s4f\ ^3F_3$	28.298	1.64[05]
$3s4p\ ^3P_1$	33.837	5.95[10]	$3p4d\ ^3D_2$	37.959	1.26[02]	$3s4f\ ^1F_3$	28.285	7.72[02]
$3s4p\ ^1P_1$	33.660	1.99[11]	$3p4d\ ^1D_2$	37.928	1.40[03]			
			$3s4p\ ^3P_2$	33.698	5.72[03]			
			$3s4f\ ^3F_2$	28.296	1.53[01]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=38$ , even-parity states								
$3d4s\ ^3D_1$	101.034	1.60[-01]	$3d4s\ ^3D_2$	102.150	6.87[05]	$3d4s\ ^3D_3$	102.476	1.06[-02]
$3d4d\ ^3S_1$	68.882	1.56[03]	$3d4s\ ^1D_2$	100.575	1.40[06]	$3d4d\ ^3G_3$	68.043	1.08[-01]
$3d4d\ ^1P_1$	68.255	9.06[01]	$3d4d\ ^3P_2$	68.214	3.37[00]	$3d4d\ ^3D_3$	67.941	1.09[-01]
$3d4d\ ^3D_1$	67.747	2.84[03]	$3d4d\ ^3D_2$	67.849	6.49[06]	$3d4d\ ^3F_3$	67.580	2.90[-02]
$3d4d\ ^3P_1$	67.556	2.19[02]	$3d4d\ ^3F_2$	67.276	6.14[06]	$3d4d\ ^1F_3$	67.152	1.88[-03]
$3p4p\ ^3D_1$	44.735	3.23[04]	$3d4d\ ^1D_2$	67.171	8.61[06]	$3p4p\ ^3D_3$	44.249	1.30[00]
$3p4p\ ^3S_1$	44.267	5.33[03]	$3p4p\ ^3D_2$	44.522	3.20[07]	$3p4f\ ^3D_3$	35.397	1.06[01]
$3p4p\ ^1P_1$	42.971	3.62[01]	$3p4p\ ^1D_2$	44.058	3.35[07]	$3p4f\ ^3G_3$	35.380	1.10[00]
$3p4p\ ^3P_1$	42.672	3.87[04]	$3p4p\ ^3P_2$	42.642	3.23[07]	$3p4f\ ^3F_3$	34.438	3.56[00]
$3p4f\ ^3D_1$	36.107	2.73[02]	$3p4f\ ^3D_2$	35.411	1.09[08]	$3s4d\ ^3D_3$	30.663	3.83[00]
$3s4s\ ^3S_1$	35.456	1.04[00]	$3p4f\ ^1D_2$	35.358	3.72[08]			
$3s4d\ ^3D_1$	30.690	4.09[01]	$3p4f\ ^3F_2$	34.376	2.44[08]			
			$3s4d\ ^3D_2$	30.675	4.27[06]			
			$3s4d\ ^1D_2$	30.643	2.16[08]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=39$ , odd-parity states								
$3d4p\ ^3P_1$	74.064	7.47[08]	$3d4p\ ^3F_2$	75.148	9.13[02]	$3d4p\ ^3F_3$	74.771	3.06[02]
$3d4p\ ^3D_1$	73.162	2.02[11]	$3d4p\ ^3P_2$	73.998	2.75[01]	$3d4p\ ^1F_3$	73.198	2.43[02]
$3d4p\ ^1P_1$	72.513	4.45[10]	$3d4p\ ^1D_2$	73.353	9.53[02]	$3d4p\ ^3D_3$	72.717	8.17[01]
$3d4f\ ^3P_1$	50.719	8.57[09]	$3d4p\ ^3D_2$	72.352	5.35[01]	$3d4f\ ^3D_3$	50.495	8.31[03]
$3d4f\ ^3D_1$	50.402	1.71[11]	$3d4f\ ^3P_2$	50.665	6.91[04]	$3d4f\ ^3G_3$	50.409	7.71[02]
$3d4f\ ^1P_1$	49.581	2.05[12]	$3d4f\ ^3D_2$	50.520	1.92[04]	$3d4f\ ^3F_3$	50.036	3.00[03]
$3p4s\ ^1P_1$	43.677	2.39[11]	$3d4f\ ^1D_2$	50.229	3.50[02]	$3d4f\ ^1F_3$	49.937	4.21[02]
$3p4s\ ^3P_1$	41.979	1.00[11]	$3d4f\ ^3F_2$	50.078	1.04[04]	$3p4d\ ^3F_3$	35.557	2.63[04]
$3p4d\ ^3P_1$	35.586	5.80[10]	$3p4s\ ^3P_2$	43.778	4.79[03]	$3p4d\ ^1F_3$	35.420	5.08[03]
$3p4d\ ^1P_1$	35.423	5.91[11]	$3p4d\ ^3F_2$	35.538	1.29[04]	$3p4d\ ^3D_3$	34.270	1.45[04]
$3p4d\ ^3D_1$	34.285	2.94[11]	$3p4d\ ^3P_2$	35.439	5.34[03]	$3s4f\ ^3F_3$	25.607	3.15[05]
$3s4p\ ^3P_1$	30.864	1.02[11]	$3p4d\ ^3D_2$	34.321	2.53[02]	$3s4f\ ^1F_3$	25.595	1.98[03]
$3s4p\ ^1P_1$	30.657	2.64[11]	$3p4d\ ^1D_2$	34.297	4.61[03]			
			$3s4p\ ^3P_2$	30.682	7.94[03]			
			$3s4f\ ^3F_2$	25.605	1.96[01]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=39$ , even-parity states								
$3d4s\ ^3D_1$	86.544	3.87[-01]	$3d4s\ ^3D_2$	87.535	1.24[06]	$3d4s\ ^3D_3$	87.796	3.51[-02]
$3d4d\ ^3S_1$	60.322	2.68[03]	$3d4s\ ^1D_2$	86.196	2.32[06]	$3d4d\ ^3G_3$	59.616	2.77[-01]
$3d4d\ ^1P_1$	59.785	8.99[01]	$3d4d\ ^3P_2$	59.755	2.21[04]	$3d4d\ ^3D_3$	59.519	2.90[-01]
$3d4d\ ^3D_1$	59.311	4.93[03]	$3d4d\ ^3D_2$	59.443	1.01[07]	$3d4d\ ^3F_3$	59.189	6.05[-02]
$3d4d\ ^3P_1$	59.144	4.48[02]	$3d4d\ ^3F_2$	58.922	9.57[06]	$3d4d\ ^1F_3$	58.812	3.22[-03]
$3p4p\ ^3D_1$	40.456	4.54[04]	$3d4d\ ^1D_2$	58.841	1.33[07]	$3p4p\ ^3D_3$	40.041	2.63[00]
$3p4p\ ^3S_1$	40.046	6.48[03]	$3p4p\ ^3D_2$	40.290	4.66[07]	$3p4f\ ^3D_3$	32.041	2.21[01]
$3p4p\ ^1P_1$	38.805	4.60[01]	$3p4p\ ^1D_2$	39.857	5.22[07]	$3p4f\ ^3G_3$	32.026	2.57[00]
$3p4p\ ^3P_1$	38.498	5.85[04]	$3p4p\ ^3P_2$	38.470	5.16[07]	$3p4f\ ^3F_3$	31.127	7.26[00]
$3p4f\ ^3D_1$	32.951	4.56[02]	$3p4f\ ^3D_2$	32.057	1.41[08]	$3s4d\ ^3D_3$	28.004	8.62[00]
$3s4s\ ^3S_1$	32.102	1.12[01]	$3p4f\ ^1D_2$	31.996	5.55[08]			
$3s4d\ ^3D_1$	28.033	6.22[01]	$3p4f\ ^3F_2$	31.070	2.79[08]			
			$3s4d\ ^3D_2$	28.018	8.43[06]			
			$3s4d\ ^1D_2$	27.986	3.63[08]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=40$ , odd-parity states								
$3d4p\ ^3P_1$	64.867	6.25[08]	$3d4p\ ^3F_2$	65.830	1.51[03]	$3d4p\ ^3F_3$	65.520	5.35[02]
$3d4p\ ^3D_1$	64.130	2.69[11]	$3d4p\ ^3P_2$	64.835	4.79[01]	$3d4p\ ^1F_3$	64.144	4.28[02]
$3d4p\ ^1P_1$	63.514	5.69[10]	$3d4p\ ^1D_2$	64.285	1.70[03]	$3d4p\ ^3D_3$	63.679	1.78[02]
$3d4f\ ^3P_1$	45.070	1.08[10]	$3d4p\ ^3D_2$	63.379	7.61[01]	$3d4f\ ^3D_3$	44.862	1.46[04]
$3d4f\ ^3D_1$	44.766	2.12[11]	$3d4f\ ^3P_2$	45.020	1.21[05]	$3d4f\ ^3G_3$	44.776	1.01[03]
$3d4f\ ^1P_1$	43.989	2.97[12]	$3d4f\ ^3D_2$	44.882	3.42[04]	$3d4f\ ^3F_3$	44.434	4.99[03]
$3p4s\ ^1P_1$	39.701	3.27[11]	$3d4f\ ^1D_2$	44.610	4.83[02]	$3d4f\ ^1F_3$	44.357	6.54[02]
$3p4s\ ^3P_1$	38.020	1.22[11]	$3d4f\ ^3F_2$	44.481	1.86[04]	$3p4d\ ^3F_3$	32.341	3.92[04]
$3p4d\ ^3P_1$	32.412	6.88[10]	$3p4s\ ^3P_2$	39.812	7.38[03]	$3p4d\ ^1F_3$	32.212	8.60[03]
$3p4d\ ^1P_1$	32.250	8.16[11]	$3p4d\ ^3F_2$	32.320	2.47[04]	$3p4d\ ^3D_3$	31.159	2.54[04]
$3p4d\ ^3D_1$	31.172	4.05[11]	$3p4d\ ^3P_2$	32.264	1.06[04]	$3s4f\ ^3F_3$	23.691	4.62[05]
$3s4p\ ^3P_1$	28.388	1.37[11]	$3p4d\ ^3D_2$	31.206	4.63[02]	$3s4f\ ^1F_3$	23.674	7.41[02]
$3s4p\ ^1P_1$	28.193	5.08[11]	$3p4d\ ^1D_2$	31.190	6.78[03]			
			$3s4p\ ^3P_2$	28.212	1.15[04]			
			$3s4f\ ^3F_2$	23.690	2.41[01]			

level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=40$ , even-parity states								
$3d4s\ ^3D_1$	75.098	6.57[-01]	$3d4s\ ^3D_2$	75.987	2.31[06]	$3d4s\ ^3D_3$	76.198	4.42[-02]
$3d4d\ ^3S_1$	53.359	4.81[03]	$3d4s\ ^1D_2$	74.824	3.69[06]	$3d4d\ ^3G_3$	52.751	3.36[-01]
$3d4d\ ^1P_1$	52.889	8.70[01]	$3d4d\ ^3P_2$	52.874	1.92[03]	$3d4d\ ^3D_3$	52.658	5.28[-01]
$3d4d\ ^3D_1$	52.455	7.45[03]	$3d4d\ ^3D_2$	52.586	1.78[07]	$3d4d\ ^3F_3$	52.356	1.13[-01]
$3d4d\ ^3P_1$	52.308	7.61[02]	$3d4d\ ^3F_2$	52.103	1.32[07]	$3d4d\ ^1F_3$	52.019	7.03[-03]
$3p4p\ ^3D_1$	36.768	7.57[04]	$3d4d\ ^1D_2$	52.055	1.99[07]	$3p4p\ ^3D_3$	36.387	4.77[00]
$3p4p\ ^3S_1$	36.415	7.41[03]	$3p4p\ ^3D_2$	36.620	7.38[07]	$3p4f\ ^3D_3$	29.176	4.55[01]
$3p4p\ ^1P_1$	35.209	7.37[01]	$3p4p\ ^1D_2$	36.229	7.77[07]	$3p4f\ ^3G_3$	29.164	5.94[00]
$3p4p\ ^3P_1$	34.919	9.86[04]	$3p4p\ ^3P_2$	34.891	7.71[07]	$3p4f\ ^3F_3$	28.301	1.30[01]
$3p4f\ ^3D_1$	30.195	8.75[02]	$3p4f\ ^3D_2$	29.197	1.87[08]	$3s4d\ ^3D_3$	25.688	1.69[01]
$3s4s\ ^3S_1$	29.238	2.34[01]	$3p4f\ ^1D_2$	29.127	7.83[08]			
$3s4d\ ^3D_1$	25.717	8.51[01]	$3p4f\ ^3F_2$	28.248	3.17[08]			
			$3s4d\ ^3D_2$	25.705	1.15[07]			
			$3s4d\ ^1D_2$	25.672	4.42[08]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=41$ , odd-parity states								
$3d4p\ ^3P_1$	57.336	2.06[08]	$3d4p\ ^3F_2$	58.230	2.22[03]	$3d4p\ ^3F_3$	57.980	8.95[02]
$3d4p\ ^3D_1$	56.745	3.35[11]	$3d4p\ ^3P_2$	57.342	7.05[01]	$3d4p\ ^1F_3$	56.736	7.18[02]
$3d4p\ ^1P_1$	56.167	6.90[10]	$3d4p\ ^1D_2$	56.863	2.81[03]	$3d4p\ ^3D_3$	56.290	3.59[02]
$3d4f\ ^3P_1$	40.382	1.37[10]	$3d4p\ ^3D_2$	56.043	1.16[02]	$3d4f\ ^3D_3$	40.188	2.45[04]
$3d4f\ ^3D_1$	40.093	2.63[11]	$3d4f\ ^3P_2$	40.331	2.02[05]	$3d4f\ ^3G_3$	40.110	1.29[03]
$3d4f\ ^1P_1$	39.352	4.11[12]	$3d4f\ ^3D_2$	40.205	5.82[04]	$3d4f\ ^3F_3$	39.789	8.02[03]
$3p4s\ ^1P_1$	36.196	4.39[11]	$3d4f\ ^1D_2$	39.949	6.68[02]	$3d4f\ ^1F_3$	39.726	9.85[02]
$3p4s\ ^3P_1$	34.607	1.45[11]	$3d4f\ ^3F_2$	39.829	3.16[04]	$3p4d\ ^3F_3$	29.598	5.77[04]
$3p4d\ ^3P_1$	29.659	6.49[10]	$3p4s\ ^3P_2$	36.286	1.08[04]	$3p4d\ ^1F_3$	29.477	1.28[04]
$3p4d\ ^1P_1$	29.504	1.08[12]	$3p4d\ ^3F_2$	29.582	3.51[04]	$3p4d\ ^3D_3$	28.468	3.61[04]
$3p4d\ ^3D_1$	28.495	5.42[11]	$3p4d\ ^3P_2$	29.517	1.81[04]	$3s4f\ ^3F_3$	21.803	7.19[05]
$3s4p\ ^3P_1$	26.098	1.79[11]	$3p4d\ ^3D_2$	28.522	7.98[02]	$3s4f\ ^1F_3$	21.779	2.97[02]
$3s4p\ ^1P_1$	25.917	5.58[11]	$3p4d\ ^1D_2$	28.497	8.68[03]			
			$3s4p\ ^3P_2$	25.932	1.64[04]			
			$3s4f\ ^3F_2$	21.801	3.10[01]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=41$ , even-parity states								
$3d4s\ ^3D_1$	65.878	9.58[-01]	$3d4s\ ^3D_2$	66.683	3.78[06]	$3d4s\ ^3D_3$	66.866	1.08[-01]
$3d4d\ ^3S_1$	47.590	8.20[03]	$3d4s\ ^1D_2$	65.644	5.83[06]	$3d4d\ ^3G_3$	47.069	6.60[-01]
$3d4d\ ^1P_1$	47.183	5.32[01]	$3d4d\ ^3P_2$	47.180	5.71[04]	$3d4d\ ^3D_3$	46.990	1.14[00]
$3d4d\ ^3D_1$	46.777	1.16[04]	$3d4d\ ^3D_2$	46.931	2.65[07]	$3d4d\ ^3F_3$	46.700	2.04[-01]
$3d4d\ ^3P_1$	46.647	1.37[03]	$3d4d\ ^3F_2$	46.473	2.04[07]	$3d4d\ ^1F_3$	46.394	9.79[-03]
$3p4p\ ^3D_1$	33.635	1.37[05]	$3d4d\ ^1D_2$	46.437	2.94[07]	$3p4p\ ^3D_3$	33.285	8.09[00]
$3p4p\ ^3S_1$	33.305	8.45[03]	$3p4p\ ^3D_2$	33.500	9.67[07]	$3p4f\ ^3D_3$	26.706	8.58[01]
$3p4p\ ^1P_1$	32.139	1.54[02]	$3p4p\ ^1D_2$	33.134	9.13[07]	$3p4f\ ^3G_3$	26.693	1.00[01]
$3p4p\ ^3P_1$	31.861	1.60[05]	$3p4p\ ^3P_2$	31.830	9.91[07]	$3p4f\ ^3F_3$	25.866	2.85[01]
$3p4f\ ^3D_1$	27.770	1.53[03]	$3p4f\ ^3D_2$	26.730	2.39[08]	$3s4d\ ^3D_3$	23.675	2.79[01]
$3s4s\ ^3S_1$	26.792	4.17[01]	$3p4f\ ^1D_2$	26.655	1.15[09]			
$3s4d\ ^3D_1$	23.705	1.89[02]	$3p4f\ ^3F_2$	25.816	5.26[08]			
			$3s4d\ ^3D_2$	23.693	2.15[07]			
			$3s4d\ ^1D_2$	23.661	6.03[08]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=42$ , odd-parity states								
$3d4p\ ^3P_1$	51.102	5.27[07]	$3d4p\ ^3F_2$	51.929	3.30[03]	$3d4p\ ^3F_3$	51.724	1.44[03]
$3d4p\ ^3D_1$	50.612	4.21[11]	$3d4p\ ^3P_2$	51.127	1.03[02]	$3d4p\ ^1F_3$	50.591	1.16[03]
$3d4p\ ^1P_1$	50.065	8.60[10]	$3d4p\ ^1D_2$	50.705	4.56[03]	$3d4p\ ^3D_3$	50.161	6.78[02]
$3d4f\ ^3P_1$	36.442	1.68[10]	$3d4p\ ^3D_2$	49.954	1.62[02]	$3d4f\ ^3D_3$	36.261	3.93[04]
$3d4f\ ^3D_1$	36.164	3.32[11]	$3d4f\ ^3P_2$	36.392	3.25[05]	$3d4f\ ^3G_3$	36.188	1.61[03]
$3d4f\ ^1P_1$	35.464	5.56[12]	$3d4f\ ^3D_2$	36.276	9.52[04]	$3d4f\ ^3F_3$	35.887	1.25[04]
$3p4s\ ^1P_1$	33.158	4.34[11]	$3d4f\ ^1D_2$	36.033	9.05[02]	$3d4f\ ^1F_3$	35.829	1.44[03]
$3p4s\ ^3P_1$	31.691	1.70[11]	$3d4f\ ^3F_2$	35.923	5.18[04]	$3p4d\ ^3F_3$	27.201	7.92[04]
$3p4d\ ^3P_1$	27.259	7.30[10]	$3p4s\ ^3P_2$	33.228	1.57[04]	$3p4d\ ^1F_3$	27.088	1.89[04]
$3p4d\ ^1P_1$	27.116	1.27[12]	$3p4d\ ^3F_2$	27.184	5.40[04]	$3p4d\ ^3D_3$	26.122	5.37[04]
$3p4d\ ^3D_1$	26.147	7.11[11]	$3p4d\ ^3P_2$	27.126	3.33[04]	$3s4f\ ^3F_3$	20.156	1.12[06]
$3s4p\ ^3P_1$	24.104	2.02[11]	$3p4d\ ^3D_2$	26.174	1.31[03]	$3s4f\ ^1F_3$	20.134	6.84[02]
$3s4p\ ^1P_1$	23.904	6.69[11]	$3p4d\ ^1D_2$	26.148	1.28[04]			
			$3s4p\ ^3P_2$	23.928	2.42[04]			
			$3s4f\ ^3F_2$	20.156	3.82[01]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=42$ , even-parity states								
$3d4s\ ^3D_1$	58.305	1.37[00]	$3d4s\ ^3D_2$	59.069	5.91[06]	$3d4s\ ^3D_3$	59.204	2.23[-01]
$3d4d\ ^3S_1$	42.755	1.30[04]	$3d4s\ ^1D_2$	58.129	8.43[06]	$3d4d\ ^3G_3$	42.306	1.15[00]
$3d4d\ ^1P_1$	42.398	4.99[01]	$3d4d\ ^3P_2$	42.401	1.92[05]	$3d4d\ ^3D_3$	42.221	2.33[00]
$3d4d\ ^3D_1$	42.023	1.68[04]	$3d4d\ ^3D_2$	42.164	3.88[07]	$3d4d\ ^3F_3$	41.956	3.47[-01]
$3d4d\ ^3P_1$	41.901	2.25[03]	$3d4d\ ^3F_2$	41.741	2.89[07]	$3d4d\ ^1F_3$	41.679	1.38[-02]
$3p4p\ ^3D_1$	30.817	1.75[05]	$3d4d\ ^1D_2$	41.726	4.02[07]	$3p4p\ ^3D_3$	30.465	1.32[01]
$3p4p\ ^3S_1$	30.544	9.40[03]	$3p4p\ ^3D_2$	30.708	1.09[08]	$3p4f\ ^3D_3$	24.559	1.51[02]
$3p4p\ ^1P_1$	29.434	2.25[02]	$3p4p\ ^1D_2$	30.343	1.22[08]	$3p4f\ ^3G_3$	24.542	1.89[01]
$3p4p\ ^3P_1$	29.146	2.24[05]	$3p4p\ ^3P_2$	29.119	1.35[08]	$3p4f\ ^3F_3$	23.748	4.72[01]
$3p4f\ ^3D_1$	25.626	2.15[03]	$3p4f\ ^3D_2$	24.584	2.84[08]	$3s4d\ ^3D_3$	21.859	4.73[01]
$3s4s\ ^3S_1$	24.620	7.42[01]	$3p4f\ ^1D_2$	24.505	1.84[09]			
$3s4d\ ^3D_1$	21.888	3.18[02]	$3p4f\ ^3F_2$	23.701	8.42[08]			
			$3s4d\ ^3D_2$	21.878	4.00[07]			
			$3s4d\ ^1D_2$	21.845	8.51[08]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=43$ , odd-parity states								
$3d4p\ ^3P_1$	45.870	9.41[08]	$3d4p\ ^3F_2$	46.642	4.76[03]	$3d4p\ ^3F_3$	46.468	2.26[03]
$3d4p\ ^3D_1$	45.457	5.15[11]	$3d4p\ ^3P_2$	45.907	1.40[02]	$3d4p\ ^1F_3$	45.427	1.82[03]
$3d4p\ ^1P_1$	44.935	1.02[11]	$3d4p\ ^1D_2$	45.529	7.15[03]	$3d4p\ ^3D_3$	45.014	1.22[03]
$3d4f\ ^3P_1$	33.091	2.27[10]	$3d4p\ ^3D_2$	44.838	2.20[02]	$3d4f\ ^3D_3$	32.922	6.07[04]
$3d4f\ ^3D_1$	32.826	4.18[11]	$3d4f\ ^3P_2$	33.041	5.04[05]	$3d4f\ ^3G_3$	32.852	1.95[03]
$3d4f\ ^1P_1$	32.162	7.26[12]	$3d4f\ ^3D_2$	32.934	1.51[05]	$3d4f\ ^3F_3$	32.567	1.91[04]
$3p4s\ ^1P_1$	30.513	4.15[11]	$3d4f\ ^1D_2$	32.700	1.71[03]	$3d4f\ ^1F_3$	32.515	2.05[03]
$3p4s\ ^3P_1$	29.086	1.95[11]	$3d4f\ ^3F_2$	32.601	8.20[04]	$3p4d\ ^3F_3$	25.092	1.24[05]
$3p4d\ ^3P_1$	25.151	7.77[10]	$3p4s\ ^3P_2$	30.577	2.22[04]	$3p4d\ ^1F_3$	24.988	2.98[04]
$3p4d\ ^1P_1$	25.010	1.36[12]	$3p4d\ ^3F_2$	25.076	7.58[04]	$3p4d\ ^3D_3$	24.060	8.24[04]
$3p4d\ ^3D_1$	24.086	9.15[11]	$3p4d\ ^3P_2$	25.024	5.33[04]	$3s4f\ ^3F_3$	18.676	1.49[06]
$3s4p\ ^3P_1$	22.333	3.26[11]	$3p4d\ ^3D_2$	24.112	2.06[03]	$3s4f\ ^1F_3$	18.656	2.50[03]
$3s4p\ ^1P_1$	22.125	6.64[11]	$3p4d\ ^1D_2$	24.085	2.92[04]			
			$3s4p\ ^3P_2$	22.160	3.52[04]			
			$3s4f\ ^3F_2$	18.674	4.66[01]			

level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=43$ , even-parity states								
$3d4s\ ^3D_1$	52.020	2.13[00]	$3d4s\ ^3D_2$	52.716	9.05[06]	$3d4s\ ^3D_3$	52.850	4.04[-01]
$3d4d\ ^3S_1$	38.662	2.02[04]	$3d4s\ ^1D_2$	51.875	1.22[07]	$3d4d\ ^3G_3$	38.262	1.77[00]
$3d4d\ ^1P_1$	38.336	1.74[01]	$3d4d\ ^3P_2$	38.347	4.19[05]	$3d4d\ ^3D_3$	38.180	4.33[00]
$3d4d\ ^3D_1$	37.991	2.46[04]	$3d4d\ ^3D_2$	38.130	5.65[07]	$3d4d\ ^3F_3$	37.932	5.69[-01]
$3d4d\ ^3P_1$	37.883	4.05[03]	$3d4d\ ^3F_2$	37.740	4.32[07]	$3d4d\ ^1F_3$	37.678	1.92[-02]
$3p4p\ ^3D_1$	28.410	2.42[05]	$3d4d\ ^1D_2$	37.728	5.24[07]	$3p4p\ ^3D_3$	28.058	2.16[01]
$3p4p\ ^3S_1$	28.152	1.11[04]	$3p4p\ ^3D_2$	28.321	1.59[08]	$3p4f\ ^3D_3$	22.673	2.86[02]
$3p4p\ ^1P_1$	27.092	4.08[02]	$3p4p\ ^1D_2$	27.937	1.49[08]	$3p4f\ ^3G_3$	22.655	3.13[01]
$3p4p\ ^3P_1$	26.815	3.06[05]	$3p4p\ ^3P_2$	26.789	1.67[08]	$3p4f\ ^3F_3$	21.889	8.46[01]
$3p4f\ ^3D_1$	23.718	4.93[03]	$3p4f\ ^3D_2$	22.699	3.13[08]	$3s4d\ ^3D_3$	20.260	7.74[01]
$3s4s\ ^3S_1$	22.733	1.32[02]	$3p4f\ ^1D_2$	22.619	2.26[09]			
$3s4d\ ^3D_1$	20.291	5.19[02]	$3p4f\ ^3F_2$	21.845	1.81[09]			
			$3s4d\ ^3D_2$	20.281	9.10[07]			
			$3s4d\ ^1D_2$	20.248	1.05[09]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=44$ , odd-parity states								
$3d4p\ ^3P_1$	41.454	8.68[08]	$3d4p\ ^3F_2$	42.145	9.71[03]	$3d4p\ ^3F_3$	42.010	3.48[03]
$3d4p\ ^3D_1$	41.147	6.23[11]	$3d4p\ ^3P_2$	41.496	1.77[02]	$3d4p\ ^1F_3$	41.043	2.84[03]
$3d4p\ ^1P_1$	40.574	1.24[11]	$3d4p\ ^1D_2$	41.150	1.33[04]	$3d4p\ ^3D_3$	40.640	2.10[03]
$3d4f\ ^3P_1$	30.211	4.59[10]	$3d4p\ ^3D_2$	40.485	2.80[02]	$3d4f\ ^3D_3$	30.056	9.22[04]
$3d4f\ ^3D_1$	29.963	6.65[11]	$3d4f\ ^3P_2$	30.174	8.27[05]	$3d4f\ ^3G_3$	29.986	2.23[03]
$3d4f\ ^1P_1$	29.326	9.43[12]	$3d4f\ ^3D_2$	30.068	2.40[05]	$3d4f\ ^3F_3$	29.713	2.84[04]
$3p4s\ ^1P_1$	28.498	4.92[11]	$3d4f\ ^1D_2$	29.836	3.29[03]	$3d4f\ ^1F_3$	29.667	2.91[03]
$3p4s\ ^3P_1$	27.076	2.22[11]	$3d4f\ ^3F_2$	29.745	1.28[05]	$3p4d\ ^3F_3$	23.237	2.28[05]
$3p4d\ ^3P_1$	23.287	6.92[10]	$3p4s\ ^3P_2$	28.574	3.07[04]	$3p4d\ ^1F_3$	23.139	4.29[04]
$3p4d\ ^1P_1$	23.165	1.65[12]	$3p4d\ ^3F_2$	23.218	1.08[05]	$3p4d\ ^3D_3$	22.231	1.11[05]
$3p4d\ ^3D_1$	22.260	1.25[12]	$3p4d\ ^3P_2$	23.177	1.05[05]	$3s4f\ ^3F_3$	17.405	2.34[06]
$3s4p\ ^3P_1$	20.787	4.24[11]	$3p4d\ ^3D_2$	22.281	3.13[03]	$3s4f\ ^1F_3$	17.391	1.46[04]
$3s4p\ ^1P_1$	20.587	7.75[11]	$3p4d\ ^1D_2$	22.254	4.55[04]			
			$3s4p\ ^3P_2$	20.619	4.91[04]			
			$3s4f\ ^3F_2$	17.404	5.07[01]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=44$ , even-parity states								
$3d4s\ ^3D_1$	46.726	3.40[00]	$3d4s\ ^3D_2$	47.388	1.33[07]	$3d4s\ ^3D_3$	47.497	7.26[-01]
$3d4d\ ^3S_1$	35.143	3.12[04]	$3d4s\ ^1D_2$	46.617	1.71[07]	$3d4d\ ^3G_3$	34.799	2.68[00]
$3d4d\ ^1P_1$	34.859	3.21[-01]	$3d4d\ ^3P_2$	34.873	8.37[05]	$3d4d\ ^3D_3$	34.718	7.78[00]
$3d4d\ ^3D_1$	34.530	3.47[04]	$3d4d\ ^3D_2$	34.673	7.99[07]	$3d4d\ ^3F_3$	34.482	8.94[-01]
$3d4d\ ^3P_1$	34.430	6.74[03]	$3d4d\ ^3F_2$	34.304	8.65[07]	$3d4d\ ^1F_3$	34.248	2.27[-02]
$3p4p\ ^3D_1$	26.245	3.40[05]	$3d4d\ ^1D_2$	34.301	4.27[07]	$3p4p\ ^3D_3$	25.910	3.35[01]
$3p4p\ ^3S_1$	26.020	1.20[04]	$3p4p\ ^3D_2$	26.173	1.89[08]	$3p4f\ ^3D_3$	21.011	4.77[02]
$3p4p\ ^1P_1$	25.011	7.61[02]	$3p4p\ ^1D_2$	25.807	1.85[08]	$3p4f\ ^3G_3$	20.992	5.87[01]
$3p4p\ ^3P_1$	24.741	4.21[05]	$3p4p\ ^3P_2$	24.721	2.37[08]	$3p4f\ ^3F_3$	20.251	1.58[02]
$3p4f\ ^3D_1$	22.017	6.05[03]	$3p4f\ ^3D_2$	21.037	4.16[08]	$3s4d\ ^3D_3$	18.833	1.24[02]
$3s4s\ ^3S_1$	21.065	2.31[02]	$3p4f\ ^1D_2$	20.956	3.63[09]			
$3s4d\ ^3D_1$	18.864	8.17[02]	$3p4f\ ^3F_2$	20.209	2.15[09]			
			$3s4d\ ^3D_2$	18.855	1.74[08]			
			$3s4d\ ^1D_2$	18.822	1.38[09]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=45$ , odd-parity states								
$3d4p\ ^3P_1$	37.632	6.46[09]	$3d4p\ ^3F_2$	38.293	9.85[03]	$3d4p\ ^3F_3$	38.186	5.10[03]
$3d4p\ ^3D_1$	37.325	7.54[11]	$3d4p\ ^3P_2$	37.683	2.52[02]	$3d4p\ ^1F_3$	37.284	4.12[03]
$3d4p\ ^1P_1$	36.844	1.34[11]	$3d4p\ ^1D_2$	37.377	1.67[04]	$3d4p\ ^3D_3$	36.894	3.40[03]
$3d4f\ ^3P_1$	27.709	2.81[10]	$3d4p\ ^3D_2$	36.765	3.58[02]	$3d4f\ ^3D_3$	27.564	1.33[05]
$3d4f\ ^3D_1$	27.469	6.73[11]	$3d4f\ ^3P_2$	27.663	1.13[06]	$3d4f\ ^3G_3$	27.501	2.64[03]
$3d4f\ ^1P_1$	26.877	1.21[13]	$3d4f\ ^3D_2$	27.573	3.50[05]	$3d4f\ ^3F_3$	27.240	4.19[04]
$3p4s\ ^1P_1$	26.092	6.17[11]	$3d4f\ ^1D_2$	27.353	5.10[03]	$3d4f\ ^1F_3$	27.197	3.87[03]
$3p4s\ ^3P_1$	24.745	2.41[11]	$3d4f\ ^3F_2$	27.270	1.89[05]	$3p4d\ ^3F_3$	21.579	2.45[05]
$3p4d\ ^3P_1$	21.623	5.86[10]	$3p4s\ ^3P_2$	26.171	3.92[04]	$3p4d\ ^1F_3$	21.483	6.27[04]
$3p4d\ ^1P_1$	21.506	2.71[12]	$3p4d\ ^3F_2$	21.561	1.56[05]	$3p4d\ ^3D_3$	20.608	1.45[05]
$3p4d\ ^3D_1$	20.641	1.62[12]	$3p4d\ ^3P_2$	21.518	1.64[05]	$3s4f\ ^3F_3$	16.214	3.11[06]
$3s4p\ ^3P_1$	19.350	4.78[11]	$3p4d\ ^3D_2$	20.662	4.65[03]	$3s4f\ ^1F_3$	16.199	1.63[04]
$3s4p\ ^1P_1$	19.148	9.30[11]	$3p4d\ ^1D_2$	20.630	6.26[04]			
			$3s4p\ ^3P_2$	19.178	6.71[04]			
			$3s4f\ ^3F_2$	16.211	7.24[01]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=45$ , even-parity states								
$3d4s\ ^3D_1$	42.233	5.25[00]	$3d4s\ ^3D_2$	42.852	1.89[07]	$3d4s\ ^3D_3$	42.956	1.34[00]
$3d4d\ ^3S_1$	32.101	4.56[04]	$3d4s\ ^1D_2$	42.139	2.27[07]	$3d4d\ ^3G_3$	31.797	4.23[00]
$3d4d\ ^1P_1$	31.838	3.77[02]	$3d4d\ ^3P_2$	31.853	1.58[06]	$3d4d\ ^3D_3$	31.731	1.40[01]
$3d4d\ ^3D_1$	31.537	4.71[04]	$3d4d\ ^3D_2$	31.691	1.03[08]	$3d4d\ ^3F_3$	31.501	1.36[00]
$3d4d\ ^3P_1$	31.427	1.16[04]	$3d4d\ ^3F_2$	31.335	1.38[08]	$3d4d\ ^1F_3$	31.285	1.39[-02]
$3p4p\ ^3D_1$	24.461	6.37[05]	$3d4d\ ^1D_2$	31.325	3.53[07]	$3p4p\ ^3D_3$	24.128	5.18[01]
$3p4p\ ^3S_1$	24.092	6.96[05]	$3p4p\ ^3D_2$	24.390	2.64[08]	$3p4f\ ^3D_3$	19.535	6.01[02]
$3p4p\ ^1P_1$	23.121	9.44[02]	$3p4p\ ^1D_2$	24.028	2.61[08]	$3p4f\ ^3G_3$	19.516	8.01[01]
$3p4p\ ^3P_1$	22.875	5.48[05]	$3p4p\ ^3P_2$	22.856	3.02[08]	$3p4f\ ^3F_3$	18.796	3.97[02]
$3p4f\ ^3D_1$	20.492	1.08[04]	$3p4f\ ^3D_2$	19.561	5.59[08]	$3s4d\ ^3D_3$	17.573	1.99[02]
$3s4s\ ^3S_1$	19.607	3.78[02]	$3p4f\ ^1D_2$	19.480	4.24[09]			
$3s4d\ ^3D_1$	17.604	1.05[03]	$3p4f\ ^3F_2$	18.756	3.97[09]			
			$3s4d\ ^3D_2$	17.595	2.64[08]			
			$3s4d\ ^1D_2$	17.563	1.76[09]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=46$ , odd-parity states								
$3d4p\ ^3P_1$	34.347	1.44[10]	$3d4p\ ^3F_2$	34.977	1.33[04]	$3d4p\ ^3F_3$	34.881	7.42[03]
$3d4p\ ^3D_1$	34.076	8.89[11]	$3d4p\ ^3P_2$	34.399	2.82[02]	$3d4p\ ^1F_3$	34.034	6.02[03]
$3d4p\ ^1P_1$	33.605	1.52[11]	$3d4p\ ^1D_2$	34.117	2.42[04]	$3d4p\ ^3D_3$	33.655	5.42[03]
$3d4f\ ^3P_1$	25.524	3.51[10]	$3d4p\ ^3D_2$	33.543	4.41[02]	$3d4f\ ^3D_3$	25.389	1.90[05]
$3d4f\ ^3D_1$	25.296	8.51[11]	$3d4f\ ^3P_2$	25.479	1.61[06]	$3d4f\ ^3G_3$	25.330	2.94[03]
$3d4f\ ^1P_1$	24.738	1.51[13]	$3d4f\ ^3D_2$	25.397	5.15[05]	$3d4f\ ^3F_3$	25.078	6.06[04]
$3p4s\ ^1P_1$	24.231	5.06[11]	$3d4f\ ^1D_2$	25.183	8.68[03]	$3d4f\ ^1F_3$	25.040	5.12[03]
$3p4s\ ^3P_1$	22.923	2.77[11]	$3d4f\ ^3F_2$	25.107	2.77[05]	$3p4d\ ^3F_3$	20.093	3.23[05]
$3p4d\ ^3P_1$	20.145	5.61[10]	$3p4s\ ^3P_2$	24.304	5.53[04]	$3p4d\ ^1F_3$	19.990	9.03[04]
$3p4d\ ^1P_1$	20.028	3.05[12]	$3p4d\ ^3F_2$	20.080	2.07[05]	$3p4d\ ^3D_3$	19.160	2.39[05]
$3p4d\ ^3D_1$	19.191	2.30[12]	$3p4d\ ^3P_2$	20.040	2.05[05]	$3s4f\ ^3F_3$	15.170	4.38[06]
$3s4p\ ^3P_1$	18.065	3.22[11]	$3p4d\ ^3D_2$	19.210	6.74[03]	$3s4f\ ^1F_3$	15.155	3.94[03]
$3s4p\ ^1P_1$	17.860	1.04[12]	$3p4d\ ^1D_2$	19.180	8.31[04]			
			$3s4p\ ^3P_2$	17.885	9.37[04]			
			$3s4f\ ^3F_2$	15.167	8.92[01]			

level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=46$ , even-parity states								
$3d4s\ ^3D_1$	38.384	7.75[00]	$3d4s\ ^3D_2$	38.966	2.67[07]	$3d4s\ ^3D_3$	39.051	2.04[00]
$3d4d\ ^3S_1$	29.478	7.38[04]	$3d4s\ ^1D_2$	38.296	3.15[07]	$3d4d\ ^3G_3$	29.195	5.42[00]
$3d4d\ ^1P_1$	29.240	3.81[02]	$3d4d\ ^3P_2$	29.259	2.59[06]	$3d4d\ ^3D_3$	29.124	2.21[01]
$3d4d\ ^3D_1$	28.931	6.48[04]	$3d4d\ ^3D_2$	29.088	1.51[08]	$3d4d\ ^3F_3$	28.900	2.07[00]
$3d4d\ ^3P_1$	28.842	1.72[04]	$3d4d\ ^3F_2$	28.757	1.54[08]	$3d4d\ ^1F_3$	28.698	1.09[-02]
$3p4p\ ^3D_1$	22.673	8.23[05]	$3d4d\ ^1D_2$	28.742	6.54[07]	$3p4p\ ^3D_3$	22.353	7.57[01]
$3p4p\ ^3S_1$	22.367	2.61[02]	$3p4p\ ^3D_2$	22.607	3.46[08]	$3p4f\ ^3D_3$	18.215	1.05[03]
$3p4p\ ^1P_1$	21.456	1.85[03]	$3p4p\ ^1D_2$	22.261	3.71[08]	$3p4f\ ^3G_3$	18.197	1.37[02]
$3p4p\ ^3P_1$	21.217	7.99[05]	$3p4p\ ^3P_2$	21.197	3.88[08]	$3p4f\ ^3F_3$	17.495	5.92[02]
$3p4f\ ^3D_1$	19.117	1.70[04]	$3p4f\ ^3D_2$	18.241	6.42[08]	$3s4d\ ^3D_3$	16.417	2.92[02]
$3s4s\ ^3S_1$	18.282	5.45[02]	$3p4f\ ^1D_2$	18.161	6.20[09]			
$3s4d\ ^3D_1$	16.449	1.56[03]	$3p4f\ ^3F_2$	17.458	4.66[09]			
			$3s4d\ ^3D_2$	16.441	3.70[08]			
			$3s4d\ ^1D_2$	16.408	2.12[09]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=47$ , odd-parity states								
$3d4p\ ^3P_1$	31.505	4.08[10]	$3d4p\ ^3F_2$	32.088	1.80[04]	$3d4p\ ^3F_3$	32.007	1.06[04]
$3d4p\ ^3D_1$	31.242	1.05[12]	$3d4p\ ^3P_2$	31.542	3.32[02]	$3d4p\ ^1F_3$	31.204	8.64[03]
$3d4p\ ^1P_1$	30.800	1.95[11]	$3d4p\ ^1D_2$	31.280	3.48[04]	$3d4p\ ^3D_3$	30.835	8.35[03]
$3d4f\ ^3P_1$	23.600	4.28[10]	$3d4p\ ^3D_2$	30.738	5.50[02]	$3d4f\ ^3D_3$	23.475	2.66[05]
$3d4f\ ^3D_1$	23.382	1.08[12]	$3d4f\ ^3P_2$	23.558	2.28[06]	$3d4f\ ^3G_3$	23.419	3.13[03]
$3d4f\ ^1P_1$	22.857	1.90[13]	$3d4f\ ^3D_2$	23.482	7.49[05]	$3d4f\ ^3F_3$	23.175	8.63[04]
$3p4s\ ^1P_1$	22.570	2.45[11]	$3d4f\ ^1D_2$	23.272	1.46[04]	$3d4f\ ^1F_3$	23.141	6.64[03]
$3p4s\ ^3P_1$	21.323	3.05[11]	$3d4f\ ^3F_2$	23.203	3.99[05]	$3p4d\ ^3F_3$	18.778	4.53[05]
$3p4d\ ^3P_1$	18.810	5.50[10]	$3p4s\ ^3P_2$	22.631	7.25[04]	$3p4d\ ^1F_3$	18.686	1.27[05]
$3p4d\ ^1P_1$	18.707	3.33[12]	$3p4d\ ^3F_2$	18.756	2.57[05]	$3p4d\ ^3D_3$	17.858	3.23[05]
$3p4d\ ^3D_1$	17.892	3.19[12]	$3p4d\ ^3P_2$	18.718	3.75[05]	$3s4f\ ^3F_3$	14.219	5.76[06]
$3s4p\ ^3P_1$	16.905	3.65[11]	$3p4d\ ^3D_2$	17.907	9.58[03]	$3s4f\ ^1F_3$	14.211	1.70[04]
$3s4p\ ^1P_1$	16.697	1.30[12]	$3p4d\ ^1D_2$	17.877	1.09[05]			
			$3s4p\ ^3P_2$	16.725	1.30[05]			
			$3s4f\ ^3F_2$	14.212	1.00[02]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=47$ , even-parity states								
$3d4s\ ^3D_1$	35.046	1.25[01]	$3d4s\ ^3D_2$	35.603	3.72[07]	$3d4s\ ^3D_3$	35.677	3.34[00]
$3d4d\ ^3S_1$	27.161	1.07[05]	$3d4s\ ^1D_2$	34.973	4.12[07]	$3d4d\ ^3G_3$	26.907	7.59[00]
$3d4d\ ^1P_1$	26.941	1.04[03]	$3d4d\ ^3P_2$	26.963	4.88[06]	$3d4d\ ^3D_3$	26.833	3.63[01]
$3d4d\ ^3D_1$	26.643	8.52[04]	$3d4d\ ^3D_2$	26.801	2.04[08]	$3d4d\ ^3F_3$	26.621	2.98[00]
$3d4d\ ^3P_1$	26.561	2.69[04]	$3d4d\ ^3F_2$	26.491	1.99[08]	$3d4d\ ^1F_3$	26.431	2.31[-02]
$3p4p\ ^3D_1$	21.141	1.06[06]	$3d4d\ ^1D_2$	26.471	8.62[07]	$3p4p\ ^3D_3$	20.817	1.08[02]
$3p4p\ ^3S_1$	20.823	2.38[03]	$3p4p\ ^3D_2$	21.083	4.48[08]	$3p4f\ ^3D_3$	17.032	1.52[03]
$3p4p\ ^1P_1$	19.980	3.12[03]	$3p4p\ ^1D_2$	20.738	4.16[08]	$3p4f\ ^3G_3$	17.014	3.26[02]
$3p4p\ ^3P_1$	19.732	1.02[06]	$3p4p\ ^3P_2$	19.718	4.45[08]	$3p4f\ ^3F_3$	16.328	7.06[02]
$3p4f\ ^3D_1$	17.876	2.45[04]	$3p4f\ ^3D_2$	17.057	7.71[08]	$3s4d\ ^3D_3$	15.368	4.34[02]
$3s4s\ ^3S_1$	17.088	8.57[02]	$3p4f\ ^1D_2$	16.979	7.67[09]			
$3s4d\ ^3D_1$	15.400	1.88[03]	$3p4f\ ^3F_2$	16.293	5.51[09]			
			$3s4d\ ^3D_2$	15.392	5.13[08]			
			$3s4d\ ^1D_2$	15.360	2.58[09]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=48$ , odd-parity states								
$3d4p\ ^3P_1$	28.980	5.10[10]	$3d4p\ ^3F_2$	29.555	2.38[04]	$3d4p\ ^3F_3$	29.485	1.48[04]
$3d4p\ ^3D_1$	28.762	1.21[12]	$3d4p\ ^3P_2$	29.036	3.56[02]	$3d4p\ ^1F_3$	28.722	1.22[04]
$3d4p\ ^1P_1$	28.343	1.93[11]	$3d4p\ ^1D_2$	28.791	4.88[04]	$3d4p\ ^3D_3$	28.361	1.25[04]
$3d4f\ ^3P_1$	21.896	4.50[10]	$3d4p\ ^3D_2$	28.277	6.68[02]	$3d4f\ ^3D_3$	21.781	3.66[05]
$3d4f\ ^3D_1$	21.688	1.35[12]	$3d4f\ ^3P_2$	21.855	3.14[06]	$3d4f\ ^3G_3$	21.728	3.14[03]
$3d4f\ ^1P_1$	21.198	2.31[13]	$3d4f\ ^3D_2$	21.787	1.07[06]	$3d4f\ ^3F_3$	21.491	1.21[05]
$3p4s\ ^1P_1$	21.068	2.13[08]	$3d4f\ ^1D_2$	21.580	2.88[04]	$3d4f\ ^1F_3$	21.460	8.39[03]
$3p4s\ ^3P_1$	19.912	3.31[11]	$3d4f\ ^3F_2$	21.517	5.62[05]	$3p4d\ ^3F_3$	17.580	5.78[05]
$3p4d\ ^3P_1$	17.609	5.37[10]	$3p4s\ ^3P_2$	21.131	9.34[04]	$3p4d\ ^1F_3$	17.492	1.79[05]
$3p4d\ ^1P_1$	17.512	3.76[12]	$3p4d\ ^3F_2$	17.559	3.08[05]	$3p4d\ ^3D_3$	16.681	4.33[05]
$3p4d\ ^3D_1$	16.714	4.03[12]	$3p4d\ ^3P_2$	17.522	4.83[05]	$3s4f\ ^3F_3$	13.350	7.47[06]
$3s4p\ ^3P_1$	15.855	4.78[11]	$3p4d\ ^3D_2$	16.728	1.34[04]	$3s4f\ ^1F_3$	13.337	4.88[04]
$3s4p\ ^1P_1$	15.655	1.40[12]	$3p4d\ ^1D_2$	16.699	1.43[05]			
			$3s4p\ ^3P_2$	15.673	1.77[05]			
			$3s4f\ ^3F_2$	13.340	1.54[02]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=48$ , even-parity states								
$3d4s\ ^3D_1$	32.139	1.88[01]	$3d4s\ ^3D_2$	32.673	5.03[07]	$3d4s\ ^3D_3$	32.738	5.25[00]
$3d4d\ ^3S_1$	25.096	1.52[05]	$3d4s\ ^1D_2$	32.077	5.31[07]	$3d4d\ ^3G_3$	24.887	1.02[01]
$3d4d\ ^1P_1$	24.910	2.42[03]	$3d4d\ ^3P_2$	24.937	8.11[06]	$3d4d\ ^3D_3$	24.814	5.72[01]
$3d4d\ ^3D_1$	24.635	1.13[05]	$3d4d\ ^3D_2$	24.784	2.70[08]	$3d4d\ ^3F_3$	24.608	4.24[00]
$3d4d\ ^3P_1$	24.545	3.89[04]	$3d4d\ ^3F_2$	24.492	2.50[08]	$3d4d\ ^1F_3$	24.430	2.60[-02]
$3p4p\ ^3D_1$	19.763	1.41[06]	$3d4d\ ^1D_2$	24.463	1.10[08]	$3p4p\ ^3D_3$	19.447	1.67[02]
$3p4p\ ^3S_1$	19.452	2.42[03]	$3p4p\ ^3D_2$	19.713	5.54[08]	$3p4f\ ^3D_3$	15.964	2.25[03]
$3p4p\ ^1P_1$	18.696	6.42[03]	$3p4p\ ^1D_2$	19.376	5.00[08]	$3p4f\ ^3G_3$	15.947	4.89[02]
$3p4p\ ^3P_1$	18.414	1.45[06]	$3p4p\ ^3P_2$	18.399	5.75[08]	$3p4f\ ^3F_3$	15.276	9.88[02]
$3p4f\ ^3D_1$	16.751	4.51[04]	$3p4f\ ^3D_2$	15.988	9.70[08]	$3s4d\ ^3D_3$	14.420	6.91[02]
$3s4s\ ^3S_1$	16.017	1.70[03]	$3p4f\ ^1D_2$	15.912	8.11[09]			
$3s4d\ ^3D_1$	14.452	2.36[03]	$3p4f\ ^3F_2$	15.243	6.80[09]			
			$3s4d\ ^3D_2$	14.445	7.61[08]			
			$3s4d\ ^1D_2$	14.413	2.90[09]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=49$ , odd-parity states								
$3d4p\ ^3P_1$	26.774	7.97[10]	$3d4p\ ^3F_2$	27.321	3.10[04]	$3d4p\ ^3F_3$	27.260	2.03[04]
$3d4p\ ^3D_1$	26.572	1.39[12]	$3d4p\ ^3P_2$	26.830	3.66[02]	$3d4p\ ^1F_3$	26.533	1.68[04]
$3d4p\ ^1P_1$	26.166	2.14[11]	$3d4p\ ^1D_2$	26.597	6.71[04]	$3d4p\ ^3D_3$	26.182	1.84[04]
$3d4f\ ^3P_1$	20.373	4.33[10]	$3d4p\ ^3D_2$	26.107	7.83[02]	$3d4f\ ^3D_3$	20.270	4.93[05]
$3d4f\ ^3D_1$	20.179	1.69[12]	$3d4f\ ^3P_2$	20.337	4.25[06]	$3d4f\ ^3G_3$	20.221	2.96[03]
$3d4f\ ^1P_1$	19.748	2.25[13]	$3d4f\ ^3D_2$	20.274	1.51[06]	$3d4f\ ^3F_3$	19.989	1.68[05]
$3p4s\ ^1P_1$	19.691	4.98[12]	$3d4f\ ^1D_2$	20.073	4.78[04]	$3d4f\ ^1F_3$	19.962	1.02[04]
$3p4s\ ^3P_1$	18.592	3.56[11]	$3d4f\ ^3F_2$	20.015	7.81[05]	$3p4d\ ^3F_3$	16.495	6.57[05]
$3p4d\ ^3P_1$	16.521	5.17[10]	$3p4s\ ^3P_2$	19.779	1.17[05]	$3p4d\ ^1F_3$	16.412	2.74[05]
$3p4d\ ^1P_1$	16.429	3.45[12]	$3p4d\ ^3F_2$	16.475	3.52[05]	$3p4d\ ^3D_3$	15.622	6.28[05]
$3p4d\ ^3D_1$	15.662	4.63[12]	$3p4d\ ^3P_2$	16.439	6.41[05]	$3s4f\ ^3F_3$	12.577	9.18[06]
$3s4p\ ^3P_1$	14.899	7.17[11]	$3p4d\ ^3D_2$	15.676	1.84[04]	$3s4f\ ^1F_3$	12.564	1.42[05]
$3s4p\ ^1P_1$	14.701	1.11[12]	$3p4d\ ^1D_2$	15.639	2.24[05]			
			$3s4p\ ^3P_2$	14.718	2.26[05]			
			$3s4f\ ^3F_2$	12.567	1.95[02]			



level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=49$ , even-parity states								
$3d4s\ ^3D_1$	29.588	2.40[01]	$3d4s\ ^3D_2$	30.104	6.69[07]	$3d4s\ ^3D_3$	30.160	7.92[00]
$3d4d\ ^3S_1$	23.290	2.09[05]	$3d4s\ ^1D_2$	29.536	6.97[07]	$3d4d\ ^3G_3$	23.094	1.31[01]
$3d4d\ ^1P_1$	23.110	4.95[03]	$3d4d\ ^3P_2$	23.139	1.26[07]	$3d4d\ ^3D_3$	23.021	8.66[01]
$3d4d\ ^3D_1$	22.846	1.51[05]	$3d4d\ ^3D_2$	22.994	3.51[08]	$3d4d\ ^3F_3$	22.822	5.98[00]
$3d4d\ ^3P_1$	22.774	6.36[04]	$3d4d\ ^3F_2$	22.716	3.16[08]	$3d4d\ ^1F_3$	22.654	1.87[-02]
$3p4p\ ^3D_1$	18.513	1.83[06]	$3d4d\ ^1D_2$	22.691	1.46[08]	$3p4p\ ^3D_3$	18.209	2.32[02]
$3p4p\ ^3S_1$	18.215	1.80[03]	$3p4p\ ^3D_2$	18.473	8.39[08]	$3p4f\ ^3D_3$	14.997	3.34[03]
$3p4p\ ^1P_1$	17.487	9.19[03]	$3p4p\ ^1D_2$	18.147	6.12[08]	$3p4f\ ^3G_3$	14.981	7.19[02]
$3p4p\ ^3P_1$	17.220	2.01[06]	$3p4p\ ^3P_2$	17.201	7.88[08]	$3p4f\ ^3F_3$	14.323	1.12[03]
$3p4f\ ^3D_1$	15.727	6.47[04]	$3p4f\ ^3D_2$	15.021	1.12[09]	$3s4d\ ^3D_3$	13.558	9.07[02]
$3s4s\ ^3S_1$	15.048	1.98[03]	$3p4f\ ^1D_2$	14.947	1.10[10]			
$3s4d\ ^3D_1$	13.590	2.64[03]	$3p4f\ ^3F_2$	14.293	8.36[09]			
			$3s4d\ ^3D_2$	13.584	9.12[08]			
			$3s4d\ ^1D_2$	13.551	3.37[09]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=50$ , odd-parity states								
$3d4p\ ^3P_1$	24.817	1.22[11]	$3d4p\ ^3F_2$	25.340	4.10[04]	$3d4p\ ^3F_3$	25.288	2.77[04]
$3d4p\ ^3D_1$	24.628	1.57[12]	$3d4p\ ^3P_2$	24.871	3.70[02]	$3d4p\ ^1F_3$	24.591	2.32[04]
$3d4p\ ^1P_1$	24.236	2.40[11]	$3d4p\ ^1D_2$	24.650	9.31[04]	$3d4p\ ^3D_3$	24.249	2.65[04]
$3d4f\ ^3P_1$	19.021	5.59[10]	$3d4p\ ^3D_2$	24.181	1.00[03]	$3d4f\ ^3D_3$	18.921	6.55[05]
$3d4f\ ^3D_1$	18.832	2.17[12]	$3d4f\ ^3P_2$	18.984	5.76[06]	$3d4f\ ^3G_3$	18.873	2.36[03]
$3d4f\ ^1P_1$	18.519	9.18[12]	$3d4f\ ^3D_2$	18.926	2.11[06]	$3d4f\ ^3F_3$	18.647	2.29[05]
$3p4s\ ^1P_1$	18.378	2.36[13]	$3d4f\ ^1D_2$	18.725	6.33[04]	$3d4f\ ^1F_3$	18.622	1.21[04]
$3p4s\ ^3P_1$	17.401	3.84[11]	$3d4f\ ^3F_2$	18.671	1.08[06]	$3p4d\ ^3F_3$	15.513	1.04[06]
$3p4d\ ^3P_1$	15.537	4.32[10]	$3p4s\ ^3P_2$	18.555	1.43[05]	$3p4d\ ^1F_3$	15.430	3.45[05]
$3p4d\ ^1P_1$	15.450	7.58[12]	$3p4d\ ^3F_2$	15.493	4.02[05]	$3p4d\ ^3D_3$	14.661	8.01[05]
$3p4d\ ^3D_1$	14.696	5.39[12]	$3p4d\ ^3P_2$	15.459	1.05[06]	$3s4f\ ^3F_3$	11.822	1.26[07]
$3s4p\ ^3P_1$	14.027	8.84[11]	$3p4d\ ^3D_2$	14.709	2.49[04]	$3s4f\ ^1F_3$	11.812	1.92[06]
$3s4p\ ^1P_1$	13.829	1.76[12]	$3p4d\ ^1D_2$	14.677	2.72[05]			
			$3s4p\ ^3P_2$	13.845	2.98[05]			
			$3s4f\ ^3F_2$	11.825	2.43[02]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=50$ , even-parity states								
$3d4s\ ^3D_1$	27.344	3.85[01]	$3d4s\ ^3D_2$	27.831	9.29[07]	$3d4s\ ^3D_3$	27.885	1.24[01]
$3d4d\ ^3S_1$	21.671	2.96[05]	$3d4s\ ^1D_2$	27.299	8.58[07]	$3d4d\ ^3G_3$	21.493	1.79[01]
$3d4d\ ^1P_1$	21.502	9.94[03]	$3d4d\ ^3P_2$	21.538	1.83[07]	$3d4d\ ^3D_3$	21.421	1.34[02]
$3d4d\ ^3D_1$	21.247	1.87[05]	$3d4d\ ^3D_2$	21.397	4.58[08]	$3d4d\ ^3F_3$	21.227	8.25[00]
$3d4d\ ^3P_1$	21.175	8.71[04]	$3d4d\ ^3F_2$	21.132	4.00[08]	$3d4d\ ^1F_3$	21.069	2.04[-03]
$3p4p\ ^3D_1$	17.400	2.48[06]	$3d4d\ ^1D_2$	21.101	1.76[08]	$3p4p\ ^3D_3$	17.085	3.89[02]
$3p4p\ ^3S_1$	17.089	4.77[01]	$3p4p\ ^3D_2$	17.368	9.52[08]	$3p4f\ ^3D_3$	14.118	5.04[03]
$3p4p\ ^1P_1$	16.376	1.70[04]	$3p4p\ ^1D_2$	17.029	6.24[08]	$3p4f\ ^3G_3$	14.103	9.06[02]
$3p4p\ ^3P_1$	16.121	2.68[06]	$3p4p\ ^3P_2$	16.103	9.88[08]	$3p4f\ ^3F_3$	13.457	2.32[03]
$3p4f\ ^3D_1$	14.791	7.05[04]	$3p4f\ ^3D_2$	14.141	1.29[09]	$3s4d\ ^3D_3$	12.768	1.32[03]
$3s4s\ ^3S_1$	14.172	2.81[03]	$3p4f\ ^1D_2$	14.070	1.59[10]			
$3s4d\ ^3D_1$	12.801	3.35[03]	$3p4f\ ^3F_2$	13.428	9.29[09]			
			$3s4d\ ^3D_2$	12.795	1.17[09]			
			$3s4d\ ^1D_2$	12.763	4.09[09]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=51$ , odd-parity states								
$3d4p\ ^3P_1$	23.074	1.78[11]	$3d4p\ ^3F_2$	23.576	5.26[04]	$3d4p\ ^3F_3$	23.530	3.77[04]
$3d4p\ ^3D_1$	22.895	1.77[12]	$3d4p\ ^3P_2$	23.125	2.99[02]	$3d4p\ ^1F_3$	22.860	3.16[04]
$3d4p\ ^1P_1$	22.515	2.66[11]	$3d4p\ ^1D_2$	22.914	1.25[05]	$3d4p\ ^3D_3$	22.525	3.72[04]
$3d4f\ ^3P_1$	17.799	6.12[10]	$3d4p\ ^3D_2$	22.465	1.14[03]	$3d4f\ ^3D_3$	17.706	8.81[05]
$3d4f\ ^3D_1$	17.618	2.73[12]	$3d4f\ ^3P_2$	17.763	7.59[06]	$3d4f\ ^3G_3$	17.660	2.15[03]
$3d4f\ ^1P_1$	17.410	5.93[12]	$3d4f\ ^3D_2$	17.710	2.91[06]	$3d4f\ ^3F_3$	17.439	3.13[05]
$3p4s\ ^1P_1$	17.190	3.26[13]	$3d4f\ ^1D_2$	17.513	9.05[04]	$3d4f\ ^1F_3$	17.417	1.52[04]
$3p4s\ ^3P_1$	16.320	4.11[11]	$3d4f\ ^3F_2$	17.462	1.47[06]	$3p4d\ ^3F_3$	14.616	1.39[06]
$3p4d\ ^3P_1$	14.638	3.72[10]	$3p4s\ ^3P_2$	17.443	1.67[05]	$3p4d\ ^1F_3$	14.536	4.42[05]
$3p4d\ ^1P_1$	14.554	8.54[12]	$3p4d\ ^3F_2$	14.597	4.58[05]	$3p4d\ ^3D_3$	13.779	1.04[06]
$3p4d\ ^3D_1$	13.818	6.17[12]	$3p4d\ ^3P_2$	14.563	2.03[06]	$3s4f\ ^3F_3$	11.216	2.69[07]
$3s4p\ ^3P_1$	13.226	9.61[11]	$3p4d\ ^3D_2$	13.826	3.32[04]	$3s4f\ ^1F_3$	11.205	5.02[05]
$3s4p\ ^1P_1$	13.034	2.18[12]	$3p4d\ ^1D_2$	13.795	3.56[05]			
			$3s4p\ ^3P_2$	13.046	3.79[05]			
			$3s4f\ ^3F_2$	11.225	3.12[02]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=51$ , even-parity states								
$3d4s\ ^3D_1$	25.349	4.42[01]	$3d4s\ ^3D_2$	25.821	1.12[08]	$3d4s\ ^3D_3$	25.869	1.77[01]
$3d4d\ ^3S_1$	20.219	4.05[05]	$3d4s\ ^1D_2$	25.307	1.10[08]	$3d4d\ ^3G_3$	20.060	2.20[01]
$3d4d\ ^1P_1$	20.062	1.83[04]	$3d4d\ ^3P_2$	20.097	2.62[07]	$3d4d\ ^3D_3$	19.988	1.93[02]
$3d4d\ ^3D_1$	19.815	2.36[05]	$3d4d\ ^3D_2$	19.965	5.69[08]	$3d4d\ ^3F_3$	19.799	1.14[01]
$3d4d\ ^3P_1$	19.744	1.26[05]	$3d4d\ ^3F_2$	19.711	4.74[08]	$3d4d\ ^1F_3$	19.647	1.23[-04]
$3p4p\ ^3D_1$	16.377	3.25[06]	$3d4d\ ^1D_2$	19.677	2.26[08]	$3p4p\ ^3D_3$	16.067	4.73[02]
$3p4p\ ^3S_1$	16.075	5.49[02]	$3p4p\ ^3D_2$	16.349	1.05[09]	$3p4f\ ^3D_3$	13.318	6.49[03]
$3p4p\ ^1P_1$	15.377	1.99[04]	$3p4p\ ^1D_2$	16.018	8.46[08]	$3p4f\ ^3G_3$	13.304	1.29[03]
$3p4p\ ^3P_1$	15.129	3.37[06]	$3p4p\ ^3P_2$	15.109	1.18[09]	$3p4f\ ^3F_3$	12.669	3.51[03]
$3p4f\ ^3D_1$	13.938	9.91[04]	$3p4f\ ^3D_2$	13.341	1.45[09]	$3s4d\ ^3D_3$	12.048	1.82[03]
$3s4s\ ^3S_1$	13.369	3.92[03]	$3p4f\ ^1D_2$	13.272	1.95[10]			
$3s4d\ ^3D_1$	12.080	3.92[03]	$3p4f\ ^3F_2$	12.642	1.36[10]			
			$3s4d\ ^3D_2$	12.073	1.51[09]			
			$3s4d\ ^1D_2$	12.041	5.19[09]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=52$ , odd-parity states								
$3d4p\ ^3P_1$	21.514	2.46[11]	$3d4p\ ^3F_2$	21.996	6.71[04]	$3d4p\ ^3F_3$	21.955	4.98[04]
$3d4p\ ^3D_1$	21.343	1.98[12]	$3d4p\ ^3P_2$	21.562	2.63[02]	$3d4p\ ^1F_3$	21.310	4.22[04]
$3d4p\ ^1P_1$	20.974	2.93[11]	$3d4p\ ^1D_2$	21.359	1.66[05]	$3d4p\ ^3D_3$	20.982	5.17[04]
$3d4f\ ^3P_1$	16.696	6.49[10]	$3d4p\ ^3D_2$	20.929	1.34[03]	$3d4f\ ^3D_3$	16.609	1.14[06]
$3d4f\ ^3D_1$	16.523	3.45[12]	$3d4f\ ^3P_2$	16.661	9.89[06]	$3d4f\ ^3G_3$	16.566	1.17[03]
$3d4f\ ^1P_1$	16.400	5.03[12]	$3d4f\ ^3D_2$	16.613	3.99[06]	$3d4f\ ^3F_3$	16.349	4.18[05]
$3p4s\ ^1P_1$	16.118	3.97[13]	$3d4f\ ^1D_2$	16.427	1.42[05]	$3d4f\ ^1F_3$	16.329	1.70[04]
$3p4s\ ^3P_1$	15.336	4.40[11]	$3d4f\ ^3F_2$	16.421	1.16[05]	$3p4d\ ^3F_3$	13.796	1.73[06]
$3p4d\ ^3P_1$	13.816	2.23[10]	$3p4s\ ^3P_2$	16.371	1.90[06]	$3p4d\ ^1F_3$	13.718	5.76[05]
$3p4d\ ^1P_1$	13.735	9.59[12]	$3p4d\ ^3F_2$	13.777	4.98[05]	$3p4d\ ^3D_3$	12.976	1.36[06]
$3p4d\ ^3D_1$	13.015	6.98[12]	$3p4d\ ^3P_2$	13.743	2.65[06]	$3s4f\ ^3F_3$	10.593	2.68[07]
$3s4p\ ^3P_1$	12.495	7.76[11]	$3p4d\ ^3D_2$	13.023	4.42[04]	$3s4f\ ^1F_3$	10.582	3.02[03]
$3s4p\ ^1P_1$	12.301	2.50[12]	$3p4d\ ^1D_2$	12.990	4.61[05]			
			$3s4p\ ^3P_2$	12.312	4.98[05]			
			$3s4f\ ^3F_2$	10.601	3.85[02]			

level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=52$ , even-parity states								
$3d4s\ ^3D_1$	23.571	8.92[01]	$3d4s\ ^3D_2$	24.029	1.45[08]	$3d4s\ ^3D_3$	24.076	2.61[01]
$3d4d\ ^3S_1$	18.912	5.50[05]	$3d4s\ ^1D_2$	23.534	1.35[08]	$3d4d\ ^3G_3$	18.768	2.87[01]
$3d4d\ ^1P_1$	18.765	3.09[04]	$3d4d\ ^3P_2$	18.803	3.97[07]	$3d4d\ ^3D_3$	18.697	2.84[02]
$3d4d\ ^3D_1$	18.526	2.99[05]	$3d4d\ ^3D_2$	18.676	7.23[08]	$3d4d\ ^3F_3$	18.512	1.53[01]
$3d4d\ ^3P_1$	18.457	1.74[05]	$3d4d\ ^3F_2$	18.433	5.95[08]	$3d4d\ ^1F_3$	18.368	3.62[-03]
$3p4p\ ^3D_1$	15.444	4.27[06]	$3d4d\ ^1D_2$	18.394	2.63[08]	$3p4p\ ^3D_3$	15.160	5.54[02]
$3p4p\ ^3S_1$	15.146	3.06[03]	$3p4p\ ^3D_2$	15.420	1.30[09]	$3p4f\ ^3D_3$	12.586	1.03[04]
$3p4p\ ^1P_1$	14.467	3.32[04]	$3p4p\ ^1D_2$	15.111	1.19[09]	$3p4f\ ^3G_3$	12.572	2.07[03]
$3p4p\ ^3P_1$	14.220	4.36[06]	$3p4p\ ^3P_2$	14.202	1.27[09]	$3p4f\ ^3F_3$	11.947	5.19[03]
$3p4f\ ^3D_1$	13.154	1.34[05]	$3p4f\ ^3D_2$	12.607	1.60[09]	$3s4d\ ^3D_3$	11.383	2.35[03]
$3s4s\ ^3S_1$	12.633	5.90[03]	$3p4f\ ^1D_2$	12.541	2.19[10]			
$3s4d\ ^3D_1$	11.416	4.60[03]	$3p4f\ ^3F_2$	11.922	1.77[10]			
			$3s4d\ ^3D_2$	11.411	2.14[09]			
			$3s4d\ ^1D_2$	11.378	6.13[09]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=53$ , odd-parity states								
$3d4p\ ^3P_1$	20.112	3.27[11]	$3d4p\ ^3F_2$	20.576	8.50[04]	$3d4p\ ^3F_3$	20.540	6.52[04]
$3d4p\ ^3D_1$	19.947	2.21[12]	$3d4p\ ^3P_2$	20.157	1.95[02]	$3d4p\ ^1F_3$	19.916	5.59[04]
$3d4p\ ^1P_1$	19.589	3.22[11]	$3d4p\ ^1D_2$	19.962	2.18[05]	$3d4p\ ^3D_3$	19.594	7.07[04]
$3d4f\ ^3P_1$	15.695	6.63[10]	$3d4p\ ^3D_2$	19.546	1.56[03]	$3d4f\ ^3D_3$	15.614	1.47[06]
$3d4f\ ^3D_1$	15.530	4.45[12]	$3d4f\ ^3P_2$	15.663	1.28[07]	$3d4f\ ^3G_3$	15.573	3.29[02]
$3d4f\ ^1P_1$	15.478	4.64[12]	$3d4f\ ^3D_2$	15.618	5.42[06]	$3d4f\ ^3F_3$	15.360	5.55[05]
$3p4s\ ^1P_1$	15.146	4.68[13]	$3d4f\ ^1D_2$	15.509	2.81[05]	$3d4f\ ^1F_3$	15.343	1.86[04]
$3p4s\ ^3P_1$	14.436	5.05[11]	$3d4f\ ^3F_2$	15.421	7.30[04]	$3p4d\ ^3F_3$	13.044	2.17[06]
$3p4d\ ^3P_1$	13.062	1.03[10]	$3p4s\ ^3P_2$	15.382	2.56[06]	$3p4d\ ^1F_3$	12.969	7.48[05]
$3p4d\ ^1P_1$	12.985	1.10[13]	$3p4d\ ^3F_2$	13.027	5.35[05]	$3p4d\ ^3D_3$	12.239	1.75[06]
$3p4d\ ^3D_1$	12.279	7.86[12]	$3p4d\ ^3P_2$	12.992	3.47[06]	$3s4f\ ^3F_3$	10.031	3.19[07]
$3s4p\ ^3P_1$	11.819	1.06[12]	$3p4d\ ^3D_2$	12.286	5.73[04]	$3s4f\ ^1F_3$	10.017	2.92[04]
$3s4p\ ^1P_1$	11.627	2.79[12]	$3p4d\ ^1D_2$	12.253	5.59[05]			
			$3s4p\ ^3P_2$	11.637	6.43[05]			
			$3s4f\ ^3F_2$	10.041	4.63[02]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=53$ , even-parity states								
$3d4s\ ^3D_1$	21.980	1.04[02]	$3d4s\ ^3D_2$	22.423	1.81[08]	$3d4s\ ^3D_3$	22.464	3.78[01]
$3d4d\ ^3S_1$	17.732	7.38[05]	$3d4s\ ^1D_2$	21.946	1.68[08]	$3d4d\ ^3G_3$	17.602	3.67[01]
$3d4d\ ^1P_1$	17.594	5.19[04]	$3d4d\ ^3P_2$	17.633	5.32[07]	$3d4d\ ^3D_3$	17.530	4.08[02]
$3d4d\ ^3D_1$	17.362	3.71[05]	$3d4d\ ^3D_2$	17.511	8.97[08]	$3d4d\ ^3F_3$	17.350	2.03[01]
$3d4d\ ^3P_1$	17.293	2.40[05]	$3d4d\ ^3F_2$	17.277	7.17[08]	$3d4d\ ^1F_3$	17.212	2.80[-02]
$3p4p\ ^3D_1$	14.590	5.53[06]	$3d4d\ ^1D_2$	17.236	3.27[08]	$3p4p\ ^3D_3$	14.302	8.59[02]
$3p4p\ ^3S_1$	14.295	1.06[04]	$3p4p\ ^3D_2$	14.567	1.51[09]	$3p4f\ ^3D_3$	11.913	1.47[04]
$3p4p\ ^1P_1$	13.633	4.06[04]	$3p4p\ ^1D_2$	14.255	1.42[09]	$3p4f\ ^3G_3$	11.901	3.23[03]
$3p4p\ ^3P_1$	13.390	5.64[06]	$3p4p\ ^3P_2$	13.374	1.64[09]	$3p4f\ ^3F_3$	11.284	7.17[03]
$3p4f\ ^3D_1$	12.433	1.82[05]	$3p4f\ ^3D_2$	11.934	1.96[09]	$3s4d\ ^3D_3$	10.772	3.89[03]
$3s4s\ ^3S_1$	11.959	8.57[03]	$3p4f\ ^1D_2$	11.870	2.60[10]			
$3s4d\ ^3D_1$	10.805	5.53[03]	$3p4f\ ^3F_2$	11.261	2.00[10]			
			$3s4d\ ^3D_2$	10.800	2.84[09]			
			$3s4d\ ^1D_2$	10.767	7.28[09]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=54$ , odd-parity states								
$3d4p\ ^3P_1$	18.846	4.25[11]	$3d4p\ ^3F_2$	19.294	1.12[05]	$3d4p\ ^3F_3$	19.262	8.48[04]
$3d4p\ ^3D_1$	18.686	2.45[12]	$3d4p\ ^3P_2$	18.889	7.84[01]	$3d4p\ ^1F_3$	18.657	7.38[04]
$3d4p\ ^1P_1$	18.338	3.46[11]	$3d4p\ ^1D_2$	18.700	2.89[05]	$3d4p\ ^3D_3$	18.342	9.82[04]
$3d4f\ ^3P_1$	14.786	6.03[10]	$3d4p\ ^3D_2$	18.299	1.79[03]	$3d4f\ ^3D_3$	14.710	1.88[06]
$3d4f\ ^3D_1$	14.628	6.45[12]	$3d4f\ ^3P_2$	14.755	1.65[07]	$3d4f\ ^3G_3$	14.671	2.03[01]
$3d4f\ ^1P_1$	14.632	3.65[12]	$3d4f\ ^3D_2$	14.713	7.30[06]	$3d4f\ ^3F_3$	14.465	7.40[05]
$3p4s\ ^1P_1$	14.262	5.47[13]	$3d4f\ ^1D_2$	14.662	2.05[05]	$3d4f\ ^1F_3$	14.447	1.87[04]
$3p4s\ ^3P_1$	13.613	5.42[11]	$3d4f\ ^3F_2$	14.529	2.26[05]	$3p4d\ ^3F_3$	12.353	2.69[06]
$3p4d\ ^3P_1$	12.369	1.27[09]	$3p4s\ ^3P_2$	14.483	3.44[06]	$3p4d\ ^1F_3$	12.280	9.93[05]
$3p4d\ ^1P_1$	12.295	1.26[13]	$3p4d\ ^3F_2$	12.336	5.74[05]	$3p4d\ ^3D_3$	11.562	2.33[06]
$3p4d\ ^3D_1$	11.603	8.67[12]	$3p4d\ ^3P_2$	12.302	4.51[06]	$3s4f\ ^3F_3$	9.514	3.79[07]
$3s4p\ ^3P_1$	11.196	9.00[11]	$3p4d\ ^3D_2$	11.609	7.55[04]	$3s4f\ ^1F_3$	9.499	1.58[05]
$3s4p\ ^1P_1$	11.006	2.48[12]	$3p4d\ ^1D_2$	11.574	7.44[05]			
			$3s4p\ ^3P_2$	11.017	8.19[05]			
			$3s4f\ ^3F_2$	9.521	5.03[02]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=54$ , even-parity states								
$3d4s\ ^3D_1$	20.549	1.36[02]	$3d4s\ ^3D_2$	20.978	2.26[08]	$3d4s\ ^3D_3$	21.015	5.37[01]
$3d4d\ ^3S_1$	16.662	9.79[05]	$3d4s\ ^1D_2$	20.518	2.06[08]	$3d4d\ ^3G_3$	16.543	4.63[01]
$3d4d\ ^1P_1$	16.531	8.35[04]	$3d4d\ ^3P_2$	16.572	7.31[07]	$3d4d\ ^3D_3$	16.472	5.79[02]
$3d4d\ ^3D_1$	16.306	4.57[05]	$3d4d\ ^3D_2$	16.455	1.11[09]	$3d4d\ ^3F_3$	16.296	2.68[01]
$3d4d\ ^3P_1$	16.239	3.25[05]	$3d4d\ ^3F_2$	16.229	8.67[08]	$3d4d\ ^1F_3$	16.164	1.04[-01]
$3p4p\ ^3D_1$	13.806	7.14[06]	$3d4d\ ^1D_2$	16.186	3.92[08]	$3p4p\ ^3D_3$	13.519	1.22[03]
$3p4p\ ^3S_1$	13.515	2.49[04]	$3p4p\ ^3D_2$	13.786	1.80[09]	$3p4f\ ^3D_3$	11.295	2.26[04]
$3p4p\ ^1P_1$	12.863	5.17[04]	$3p4p\ ^1D_2$	13.472	1.69[09]	$3p4f\ ^3G_3$	11.283	4.39[03]
$3p4p\ ^3P_1$	12.629	7.22[06]	$3p4p\ ^3P_2$	12.614	1.95[09]	$3p4f\ ^3F_3$	10.674	9.14[03]
$3p4f\ ^3D_1$	11.768	2.48[05]	$3p4f\ ^3D_2$	11.315	2.20[09]	$3s4d\ ^3D_3$	10.207	4.97[03]
$3s4s\ ^3S_1$	11.338	1.11[04]	$3p4f\ ^1D_2$	11.253	2.92[10]			
$3s4d\ ^3D_1$	10.240	6.23[03]	$3p4f\ ^3F_2$	10.653	2.43[10]			
			$3s4d\ ^3D_2$	10.235	3.65[09]			
			$3s4d\ ^1D_2$	10.203	8.27[09]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=55$ , odd-parity states								
$3d4p\ ^3P_1$	17.700	5.35[11]	$3d4p\ ^3F_2$	18.133	1.34[05]	$3d4p\ ^3F_3$	18.104	1.08[05]
$3d4p\ ^3D_1$	17.544	2.71[12]	$3d4p\ ^3P_2$	17.740	2.08[01]	$3d4p\ ^1F_3$	17.517	9.51[04]
$3d4p\ ^1P_1$	17.204	3.80[11]	$3d4p\ ^1D_2$	17.556	3.65[05]	$3d4p\ ^3D_3$	17.207	1.27[05]
$3d4f\ ^3P_1$	13.955	4.70[10]	$3d4p\ ^3D_2$	17.168	1.90[03]	$3d4f\ ^3D_3$	13.884	2.36[06]
$3d4f\ ^3D_1$	13.856	7.42[12]	$3d4f\ ^3P_2$	13.926	2.07[07]	$3d4f\ ^3G_3$	13.847	1.20[03]
$3d4f\ ^1P_1$	13.803	4.01[12]	$3d4f\ ^3D_2$	13.887	9.68[06]	$3d4f\ ^3F_3$	13.640	9.50[05]
$3p4s\ ^1P_1$	13.456	6.29[13]	$3d4f\ ^1D_2$	13.882	7.33[03]	$3d4f\ ^1F_3$	13.627	1.93[04]
$3p4s\ ^3P_1$	12.856	5.85[11]	$3d4f\ ^3F_2$	13.694	2.52[05]	$3p4d\ ^3F_3$	11.714	2.85[06]
$3p4d\ ^3P_1$	11.729	6.30[09]	$3p4s\ ^3P_2$	13.661	4.40[06]	$3p4d\ ^1F_3$	11.644	1.24[06]
$3p4d\ ^1P_1$	11.658	1.42[13]	$3p4d\ ^3F_2$	11.697	6.18[05]	$3p4d\ ^3D_3$	10.939	2.99[06]
$3p4d\ ^3D_1$	10.979	9.12[12]	$3p4d\ ^3P_2$	11.666	5.80[06]	$3s4f\ ^3F_3$	9.036	4.72[07]
$3s4p\ ^3P_1$	10.621	9.77[11]	$3p4d\ ^3D_2$	10.984	9.62[04]	$3s4f\ ^1F_3$	9.021	3.14[05]
$3s4p\ ^1P_1$	10.431	2.74[12]	$3p4d\ ^1D_2$	10.950	9.20[05]			
			$3s4p\ ^3P_2$	10.440	1.03[06]			
			$3s4f\ ^3F_2$	9.043	7.24[02]			

level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=55$ , even-parity states								
$3d4s\ ^3D_1$	19.246	1.88[02]	$3d4s\ ^3D_2$	19.675	2.81[08]	$3d4s\ ^3D_3$	19.708	7.55[01]
$3d4d\ ^3S_1$	15.689	1.29[06]	$3d4s\ ^1D_2$	19.228	2.48[08]	$3d4d\ ^3G_3$	15.580	5.85[01]
$3d4d\ ^1P_1$	15.564	1.30[05]	$3d4d\ ^3P_2$	15.607	1.03[08]	$3d4d\ ^3D_3$	15.509	7.99[02]
$3d4d\ ^3D_1$	15.347	5.62[05]	$3d4d\ ^3D_2$	15.493	1.36[09]	$3d4d\ ^3F_3$	15.336	3.54[01]
$3d4d\ ^3P_1$	15.279	4.34[05]	$3d4d\ ^3F_2$	15.275	1.03[09]	$3d4d\ ^1F_3$	15.209	4.35[-01]
$3p4p\ ^3D_1$	13.086	9.16[06]	$3d4d\ ^1D_2$	15.229	4.58[08]	$3p4p\ ^3D_3$	12.801	1.69[03]
$3p4p\ ^3S_1$	12.798	4.88[04]	$3p4p\ ^3D_2$	13.068	2.18[09]	$3p4f\ ^3D_3$	10.724	3.43[04]
$3p4p\ ^1P_1$	12.179	7.50[04]	$3p4p\ ^1D_2$	12.758	1.99[09]	$3p4f\ ^3G_3$	10.714	5.97[03]
$3p4p\ ^3P_1$	11.929	9.19[06]	$3p4p\ ^3P_2$	11.914	2.18[09]	$3p4f\ ^3F_3$	10.112	1.02[04]
$3p4f\ ^3D_1$	11.155	3.55[05]	$3p4f\ ^3D_2$	10.744	2.35[09]	$3s4d\ ^3D_3$	9.684	6.81[03]
$3s4s\ ^3S_1$	10.766	1.61[04]	$3p4f\ ^1D_2$	10.685	3.84[10]			
$3s4d\ ^3D_1$	9.718	7.32[03]	$3p4f\ ^3F_2$	10.093	2.75[10]			
			$3s4d\ ^3D_2$	9.713	4.48[09]			
			$3s4d\ ^1D_2$	9.680	9.21[09]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=56$ , odd-parity states								
$3d4p\ ^3P_1$	16.655	6.82[11]	$3d4p\ ^3F_2$	17.078	1.67[05]	$3d4p\ ^3F_3$	17.052	1.39[05]
$3d4p\ ^3D_1$	16.505	2.97[12]	$3d4p\ ^3P_2$	16.693	4.40[-01]	$3d4p\ ^1F_3$	16.480	1.23[05]
$3d4p\ ^1P_1$	16.174	4.15[11]	$3d4p\ ^1D_2$	16.517	4.65[05]	$3d4p\ ^3D_3$	16.176	1.68[05]
$3d4f\ ^3P_1$	13.195	4.22[10]	$3d4p\ ^3D_2$	16.141	2.27[03]	$3d4f\ ^3D_3$	13.128	2.96[06]
$3d4f\ ^3D_1$	13.142	6.57[12]	$3d4f\ ^3P_2$	13.171	2.52[07]	$3d4f\ ^3G_3$	13.092	5.15[03]
$3d4f\ ^1P_1$	13.048	6.45[12]	$3d4f\ ^3D_2$	13.144	1.06[07]	$3d4f\ ^3F_3$	12.889	1.23[06]
$3p4s\ ^1P_1$	12.718	7.17[13]	$3d4f\ ^1D_2$	13.133	1.32[07]	$3d4f\ ^1F_3$	12.877	1.85[04]
$3p4s\ ^3P_1$	12.160	6.34[11]	$3d4f\ ^3F_2$	12.939	3.45[05]	$3p4d\ ^3F_3$	11.127	4.10[06]
$3p4d\ ^3P_1$	11.150	1.05[10]	$3p4s\ ^3P_2$	12.909	5.65[06]	$3p4d\ ^1F_3$	11.052	1.62[06]
$3p4d\ ^1P_1$	11.077	1.58[13]	$3p4d\ ^3F_2$	11.111	6.40[05]	$3p4d\ ^3D_3$	10.362	3.84[06]
$3p4d\ ^3D_1$	10.404	9.33[12]	$3p4d\ ^3P_2$	11.084	6.97[06]	$3s4f\ ^3F_3$	8.593	5.69[07]
$3s4p\ ^3P_1$	10.086	1.08[12]	$3p4d\ ^3D_2$	10.408	1.25[05]	$3s4f\ ^1F_3$	8.577	6.38[05]
$3s4p\ ^1P_1$	9.899	2.75[12]	$3p4d\ ^1D_2$	10.373	1.24[06]			
			$3s4p\ ^3P_2$	9.907	1.30[06]			
			$3s4f\ ^3F_2$	8.598	8.98[02]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=56$ , even-parity states								
$3d4s\ ^3D_1$	18.083	2.13[02]	$3d4s\ ^3D_2$	18.494	3.44[08]	$3d4s\ ^3D_3$	18.524	1.04[02]
$3d4d\ ^3S_1$	14.800	1.69[06]	$3d4s\ ^1D_2$	18.060	2.96[08]	$3d4d\ ^3G_3$	14.701	7.33[01]
$3d4d\ ^1P_1$	14.681	2.00[05]	$3d4d\ ^3P_2$	14.725	1.35[08]	$3d4d\ ^3D_3$	14.630	1.13[03]
$3d4d\ ^3D_1$	14.469	6.80[05]	$3d4d\ ^3D_2$	14.615	1.63[09]	$3d4d\ ^3F_3$	14.461	4.50[01]
$3d4d\ ^3P_1$	14.403	5.69[05]	$3d4d\ ^3F_2$	14.404	1.23[09]	$3d4d\ ^1F_3$	14.338	2.94[-01]
$3p4p\ ^3D_1$	12.422	1.18[07]	$3d4d\ ^1D_2$	14.357	5.31[08]	$3p4p\ ^3D_3$	12.139	2.30[03]
$3p4p\ ^3S_1$	12.136	9.82[04]	$3p4p\ ^3D_2$	12.406	2.56[09]	$3p4f\ ^3D_3$	10.196	4.49[04]
$3p4p\ ^1P_1$	11.530	8.95[04]	$3p4p\ ^1D_2$	12.099	2.32[09]	$3p4f\ ^3G_3$	10.187	7.75[03]
$3p4p\ ^3P_1$	11.284	1.15[07]	$3p4p\ ^3P_2$	11.269	2.41[09]	$3p4f\ ^3F_3$	9.592	1.18[04]
$3p4f\ ^3D_1$	10.586	1.07[06]	$3p4f\ ^3D_2$	10.215	2.84[09]	$3s4d\ ^3D_3$	9.199	9.04[03]
$3s4s\ ^3S_1$	10.237	1.84[04]	$3p4f\ ^1D_2$	10.159	4.97[10]			
$3s4d\ ^3D_1$	9.233	8.14[03]	$3p4f\ ^3F_2$	9.573	3.22[10]			
			$3s4d\ ^3D_2$	9.229	5.31[09]			
			$3s4d\ ^1D_2$	9.196	1.14[10]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=57$ , odd-parity states								
$3d4p\ ^3P_1$	15.708	8.16[11]	$3d4p\ ^3F_2$	16.116	2.01[05]	$3d4p\ ^3F_3$	16.092	1.75[05]
$3d4p\ ^3D_1$	15.556	3.25[12]	$3d4p\ ^3P_2$	15.743	9.82[01]	$3d4p\ ^1F_3$	15.527	1.54[05]
$3d4p\ ^1P_1$	15.235	4.46[11]	$3d4p\ ^1D_2$	15.563	5.76[05]	$3d4p\ ^3D_3$	15.236	2.17[05]
$3d4f\ ^3P_1$	12.498	5.94[06]	$3d4p\ ^3D_2$	15.203	2.41[03]	$3d4f\ ^3D_3$	12.434	3.64[06]
$3d4f\ ^3D_1$	12.481	6.79[12]	$3d4f\ ^3P_2$	12.502	1.17[07]	$3d4f\ ^3G_3$	12.400	1.22[04]
$3d4f\ ^1P_1$	12.355	8.56[12]	$3d4f\ ^3D_2$	12.461	1.85[07]	$3d4f\ ^3F_3$	12.199	1.58[06]
$3p4s\ ^1P_1$	12.041	8.21[13]	$3d4f\ ^1D_2$	12.436	1.73[07]	$3d4f\ ^1F_3$	12.189	1.52[04]
$3p4s\ ^3P_1$	11.518	1.11[12]	$3d4f\ ^3F_2$	12.246	4.49[05]	$3p4d\ ^3F_3$	10.582	4.56[06]
$3p4d\ ^3P_1$	10.601	3.72[10]	$3p4s\ ^3P_2$	12.218	7.25[06]	$3p4d\ ^1F_3$	10.501	2.15[06]
$3p4d\ ^1P_1$	10.534	1.78[13]	$3p4d\ ^3F_2$	10.566	6.74[05]	$3p4d\ ^3D_3$	9.829	4.76[06]
$3p4d\ ^3D_1$	9.871	9.74[12]	$3p4d\ ^3P_2$	10.537	8.38[06]	$3s4f\ ^3F_3$	8.180	6.81[07]
$3s4p\ ^3P_1$	9.590	2.42[12]	$3p4d\ ^3D_2$	9.874	1.52[05]	$3s4f\ ^1F_3$	8.165	1.23[06]
$3s4p\ ^1P_1$	9.406	2.89[12]	$3p4d\ ^1D_2$	9.839	1.65[06]			
			$3s4p\ ^3P_2$	9.413	1.62[06]			
			$3s4f\ ^3F_2$	8.186	1.04[03]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=57$ , even-parity states								
$3d4s\ ^3D_1$	17.019	3.19[02]	$3d4s\ ^3D_2$	17.420	4.19[08]	$3d4s\ ^3D_3$	17.448	1.40[02]
$3d4d\ ^3S_1$	13.987	2.15[06]	$3d4s\ ^1D_2$	16.998	3.64[08]	$3d4d\ ^3G_3$	13.896	8.63[01]
$3d4d\ ^1P_1$	13.873	2.92[05]	$3d4d\ ^3P_2$	13.919	1.69[08]	$3d4d\ ^3D_3$	13.825	1.47[03]
$3d4d\ ^3D_1$	13.666	8.37[05]	$3d4d\ ^3D_2$	13.812	2.00[09]	$3d4d\ ^3F_3$	13.659	5.94[01]
$3d4d\ ^3P_1$	13.599	7.50[05]	$3d4d\ ^3F_2$	13.606	1.48[09]	$3d4d\ ^1F_3$	13.540	1.60[00]
$3p4p\ ^3D_1$	11.809	1.46[07]	$3d4d\ ^1D_2$	13.557	6.72[08]	$3p4p\ ^3D_3$	11.527	2.86[03]
$3p4p\ ^3S_1$	11.525	1.28[05]	$3p4p\ ^3D_2$	11.794	2.95[09]	$3p4f\ ^3D_3$	9.707	5.23[04]
$3p4p\ ^1P_1$	10.930	1.18[05]	$3p4p\ ^1D_2$	11.490	2.85[09]	$3p4f\ ^3G_3$	9.699	9.16[03]
$3p4p\ ^3P_1$	10.687	1.50[07]	$3p4p\ ^3P_2$	10.674	3.12[09]	$3p4f\ ^3F_3$	9.110	1.98[04]
$3p4f\ ^3D_1$	10.059	1.60[05]	$3p4f\ ^3D_2$	9.726	3.20[09]	$3s4d\ ^3D_3$	8.749	1.11[04]
$3s4s\ ^3S_1$	9.745	2.23[04]	$3p4f\ ^1D_2$	9.671	5.87[10]			
$3s4d\ ^3D_1$	8.783	9.14[03]	$3p4f\ ^3F_2$	9.093	3.96[10]			
			$3s4d\ ^3D_2$	8.778	6.27[09]			
			$3s4d\ ^1D_2$	8.746	1.39[10]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=58$ , odd-parity states								
$3d4p\ ^3P_1$	14.840	9.70[11]	$3d4p\ ^3F_2$	15.237	2.54[05]	$3d4p\ ^3F_3$	15.219	2.21[05]
$3d4p\ ^3D_1$	14.692	3.61[12]	$3d4p\ ^3P_2$	14.873	2.49[02]	$3d4p\ ^1F_3$	14.670	2.00[05]
$3d4p\ ^1P_1$	14.375	4.80[11]	$3d4p\ ^1D_2$	14.702	7.42[05]	$3d4p\ ^3D_3$	14.376	2.84[05]
$3d4f\ ^3P_1$	11.863	2.35[12]	$3d4p\ ^3D_2$	14.347	2.59[03]	$3d4f\ ^3D_3$	11.796	4.55[06]
$3d4f\ ^3D_1$	11.855	4.92[12]	$3d4f\ ^3P_2$	11.896	5.84[06]	$3d4f\ ^3G_3$	11.762	3.31[04]
$3d4f\ ^1P_1$	11.717	1.01[13]	$3d4f\ ^3D_2$	11.825	3.17[07]	$3d4f\ ^3F_3$	11.564	2.00[06]
$3p4s\ ^1P_1$	11.416	9.17[13]	$3d4f\ ^1D_2$	11.797	2.30[07]	$3d4f\ ^1F_3$	11.555	1.26[04]
$3p4s\ ^3P_1$	10.922	1.04[12]	$3d4f\ ^3F_2$	11.608	5.94[05]	$3p4d\ ^3F_3$	10.093	6.82[06]
$3p4d\ ^3P_1$	10.092	9.90[10]	$3p4s\ ^3P_2$	11.583	9.29[06]	$3p4d\ ^1F_3$	10.014	2.85[06]
$3p4d\ ^1P_1$	10.027	1.98[13]	$3p4d\ ^3F_2$	10.077	7.16[05]	$3p4d\ ^3D_3$	9.334	5.82[06]
$3p4d\ ^3D_1$	9.377	1.11[13]	$3p4d\ ^3P_2$	10.030	1.21[07]	$3s4f\ ^3F_3$	7.795	8.29[07]
$3s4p\ ^3P_1$	9.131	3.58[12]	$3p4d\ ^3D_2$	9.379	1.96[05]	$3s4f\ ^1F_3$	7.779	1.80[06]
$3s4p\ ^1P_1$	8.945	3.06[12]	$3p4d\ ^1D_2$	9.344	2.12[06]			
			$3s4p\ ^3P_2$	8.952	2.02[06]			
			$3s4f\ ^3F_2$	7.799	1.52[03]			

level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=58$ , even-parity states								
$3d4s\ ^3D_1$	16.047	4.18[02]	$3d4s\ ^3D_2$	16.441	5.09[08]	$3d4s\ ^3D_3$	16.467	1.90[02]
$3d4d\ ^3S_1$	13.240	2.72[06]	$3d4s\ ^1D_2$	16.017	4.16[08]	$3d4d\ ^3G_3$	13.157	1.07[02]
$3d4d\ ^1P_1$	13.130	4.19[05]	$3d4d\ ^3P_2$	13.178	2.22[08]	$3d4d\ ^3D_3$	13.086	2.00[03]
$3d4d\ ^3D_1$	12.929	1.02[06]	$3d4d\ ^3D_2$	13.074	2.40[09]	$3d4d\ ^3F_3$	12.923	7.56[01]
$3d4d\ ^3P_1$	12.863	9.76[05]	$3d4d\ ^3F_2$	12.874	1.72[09]	$3d4d\ ^1F_3$	12.808	2.35[00]
$3p4p\ ^3D_1$	11.241	1.82[07]	$3d4d\ ^1D_2$	12.823	7.32[08]	$3p4p\ ^3D_3$	10.961	3.83[03]
$3p4p\ ^3S_1$	10.958	1.73[05]	$3p4p\ ^3D_2$	11.227	3.51[09]	$3p4f\ ^3D_3$	9.253	6.21[04]
$3p4p\ ^1P_1$	10.374	1.65[05]	$3p4p\ ^1D_2$	10.927	3.28[09]	$3p4f\ ^3G_3$	9.250	1.04[04]
$3p4p\ ^3P_1$	10.139	1.96[07]	$3p4p\ ^3P_2$	10.129	4.48[09]	$3p4f\ ^3F_3$	8.662	2.64[04]
$3p4f\ ^3D_1$	9.569	5.79[04]	$3p4f\ ^3D_2$	9.271	3.65[09]	$3s4d\ ^3D_3$	8.328	1.42[04]
$3s4s\ ^3S_1$	9.288	3.88[04]	$3p4f\ ^1D_2$	9.219	6.87[10]			
$3s4d\ ^3D_1$	8.362	1.16[04]	$3p4f\ ^3F_2$	8.647	4.51[10]			
			$3s4d\ ^3D_2$	8.358	7.21[09]			
			$3s4d\ ^1D_2$	8.325	1.75[10]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=59$ , odd-parity states								
$3d4p\ ^3P_1$	14.044	1.15[12]	$3d4p\ ^3F_2$	14.430	3.10[05]	$3d4p\ ^3F_3$	14.413	2.74[05]
$3d4p\ ^3D_1$	13.897	3.94[12]	$3d4p\ ^3P_2$	14.075	5.47[02]	$3d4p\ ^1F_3$	13.877	2.51[05]
$3d4p\ ^1P_1$	13.587	5.23[11]	$3d4p\ ^1D_2$	13.907	9.28[05]	$3d4p\ ^3D_3$	13.588	3.63[05]
$3d4f\ ^3P_1$	11.308	6.77[12]	$3d4p\ ^3D_2$	13.561	2.93[03]	$3d4f\ ^3D_3$	11.206	5.54[06]
$3d4f\ ^3D_1$	11.260	8.59[11]	$3d4f\ ^3P_2$	11.329	4.87[06]	$3d4f\ ^3G_3$	11.174	6.66[04]
$3d4f\ ^1P_1$	11.129	1.23[13]	$3d4f\ ^3D_2$	11.233	4.02[07]	$3d4f\ ^3F_3$	10.978	2.52[06]
$3p4s\ ^1P_1$	10.841	1.03[14]	$3d4f\ ^1D_2$	11.207	3.03[07]	$3d4f\ ^1F_3$	10.971	7.65[03]
$3p4s\ ^3P_1$	10.371	1.16[12]	$3d4f\ ^3F_2$	11.020	7.36[05]	$3p4d\ ^3F_3$	9.614	7.76[06]
$3p4d\ ^3P_1$	9.621	1.07[11]	$3p4s\ ^3P_2$	10.996	1.17[07]	$3p4d\ ^1F_3$	9.545	3.17[06]
$3p4d\ ^1P_1$	9.557	2.22[13]	$3p4d\ ^3F_2$	9.599	7.46[05]	$3p4d\ ^3D_3$	8.874	7.25[06]
$3p4d\ ^3D_1$	8.918	1.25[13]	$3p4d\ ^3P_2$	9.562	1.61[07]	$3s4f\ ^3F_3$	7.436	9.69[07]
$3s4p\ ^3P_1$	8.701	3.99[12]	$3p4d\ ^3D_2$	8.919	2.41[05]	$3s4f\ ^1F_3$	7.422	3.17[06]
$3s4p\ ^1P_1$	8.516	4.75[12]	$3p4d\ ^1D_2$	8.884	2.62[06]			
			$3s4p\ ^3P_2$	8.523	2.46[06]			
			$3s4f\ ^3F_2$	7.441	1.93[03]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=59$ , even-parity states								
$3d4s\ ^3D_1$	15.162	6.06[02]	$3d4s\ ^3D_2$	15.546	6.07[08]	$3d4s\ ^3D_3$	15.570	2.55[02]
$3d4d\ ^3S_1$	12.553	3.55[06]	$3d4s\ ^1D_2$	15.146	5.15[08]	$3d4d\ ^3G_3$	12.477	1.31[02]
$3d4d\ ^1P_1$	12.449	6.14[05]	$3d4d\ ^3P_2$	12.496	2.78[08]	$3d4d\ ^3D_3$	12.406	2.67[03]
$3d4d\ ^3D_1$	12.251	1.21[06]	$3d4d\ ^3D_2$	12.395	2.83[09]	$3d4d\ ^3F_3$	12.245	9.60[01]
$3d4d\ ^3P_1$	12.185	1.21[06]	$3d4d\ ^3F_2$	12.200	2.05[09]	$3d4d\ ^1F_3$	12.134	3.76[00]
$3p4p\ ^3D_1$	10.713	2.36[07]	$3d4d\ ^1D_2$	12.149	9.21[08]	$3p4p\ ^3D_3$	10.435	5.02[03]
$3p4p\ ^3S_1$	10.434	3.59[05]	$3p4p\ ^3D_2$	10.702	4.02[09]	$3p4f\ ^3D_3$	8.834	7.16[04]
$3p4p\ ^1P_1$	9.860	1.76[05]	$3p4p\ ^1D_2$	10.404	3.88[09]	$3p4f\ ^3G_3$	8.825	1.77[04]
$3p4p\ ^3P_1$	9.625	2.24[07]	$3p4p\ ^3P_2$	9.619	5.78[09]	$3p4f\ ^3F_3$	8.245	3.66[04]
$3p4f\ ^3D_1$	9.120	2.47[06]	$3p4f\ ^3D_2$	8.851	4.08[09]	$3s4d\ ^3D_3$	7.939	2.15[04]
$3s4s\ ^3S_1$	8.866	4.48[04]	$3p4f\ ^1D_2$	8.805	8.05[10]			
$3s4d\ ^3D_1$	7.973	1.51[04]	$3p4f\ ^3F_2$	8.231	5.20[10]			
			$3s4d\ ^3D_2$	7.969	8.29[09]			
			$3s4d\ ^1D_2$	7.936	2.00[10]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=60$ , odd-parity states								
$3d4p\ ^3P_1$	13.312	1.30[12]	$3d4p\ ^3F_2$	13.689	3.77[05]	$3d4p\ ^3F_3$	13.673	3.39[05]
$3d4p\ ^3D_1$	13.166	4.33[12]	$3d4p\ ^3P_2$	13.341	1.03[03]	$3d4p\ ^1F_3$	13.148	3.14[05]
$3d4p\ ^1P_1$	12.863	5.56[11]	$3d4p\ ^1D_2$	13.175	1.15[06]	$3d4p\ ^3D_3$	12.863	4.62[05]
$3d4f\ ^3P_1$	10.783	8.55[12]	$3d4p\ ^3D_2$	12.838	3.24[03]	$3d4f\ ^3D_3$	10.661	6.72[06]
$3d4f\ ^3D_1$	10.711	4.59[11]	$3d4f\ ^3P_2$	10.803	4.84[06]	$3d4f\ ^3G_3$	10.630	1.24[05]
$3d4f\ ^1P_1$	10.585	1.47[13]	$3d4f\ ^3D_2$	10.686	4.85[07]	$3d4f\ ^3F_3$	10.436	3.16[06]
$3p4s\ ^1P_1$	10.309	1.16[14]	$3d4f\ ^1D_2$	10.662	3.96[07]	$3d4f\ ^1F_3$	10.430	2.98[03]
$3p4s\ ^3P_1$	9.860	1.31[12]	$3d4f\ ^3F_2$	10.475	8.85[05]	$3p4d\ ^3F_3$	9.175	9.29[06]
$3p4d\ ^3P_1$	9.183	1.54[11]	$3p4s\ ^3P_2$	10.454	1.47[07]	$3p4d\ ^1F_3$	9.111	3.96[06]
$3p4d\ ^1P_1$	9.120	2.55[13]	$3p4d\ ^3F_2$	9.162	7.74[05]	$3p4d\ ^3D_3$	8.446	8.97[06]
$3p4d\ ^3D_1$	8.490	1.38[13]	$3p4d\ ^3P_2$	9.124	1.97[07]	$3s4f\ ^3F_3$	7.103	1.12[08]
$3s4p\ ^3P_1$	8.305	4.00[12]	$3p4d\ ^3D_2$	8.490	3.00[05]	$3s4f\ ^1F_3$	7.090	5.21[06]
$3s4p\ ^1P_1$	8.116	5.02[12]	$3p4d\ ^1D_2$	8.455	3.39[06]			
			$3s4p\ ^3P_2$	8.123	3.03[06]			
			$3s4f\ ^3F_2$	7.104	2.47[03]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=60$ , even-parity states								
$3d4s\ ^3D_1$	14.349	7.16[02]	$3d4s\ ^3D_2$	14.725	7.24[08]	$3d4s\ ^3D_3$	14.747	3.37[02]
$3d4d\ ^3S_1$	11.920	4.46[06]	$3d4s\ ^1D_2$	14.334	6.06[08]	$3d4d\ ^3G_3$	11.849	1.59[02]
$3d4d\ ^1P_1$	11.818	8.59[05]	$3d4d\ ^3P_2$	11.867	3.51[08]	$3d4d\ ^3D_3$	11.779	3.53[03]
$3d4d\ ^3D_1$	11.625	1.46[06]	$3d4d\ ^3D_2$	11.768	3.35[09]	$3d4d\ ^3F_3$	11.620	1.21[02]
$3d4d\ ^3P_1$	11.560	1.54[06]	$3d4d\ ^3F_2$	11.578	2.40[09]	$3d4d\ ^1F_3$	11.512	5.74[00]
$3p4p\ ^3D_1$	10.224	2.92[07]	$3d4d\ ^1D_2$	11.526	1.07[09]	$3p4p\ ^3D_3$	9.947	6.48[03]
$3p4p\ ^3S_1$	9.946	4.96[05]	$3p4p\ ^3D_2$	10.213	4.65[09]	$3p4f\ ^3D_3$	8.438	8.18[04]
$3p4p\ ^1P_1$	9.382	2.22[05]	$3p4p\ ^1D_2$	9.917	4.50[09]	$3p4f\ ^3G_3$	8.430	2.71[04]
$3p4p\ ^3P_1$	9.149	2.84[07]	$3p4p\ ^3P_2$	9.141	6.26[09]	$3p4f\ ^3F_3$	7.856	4.76[04]
$3p4f\ ^3D_1$	8.691	1.90[06]	$3p4f\ ^3D_2$	8.455	3.62[09]	$3s4d\ ^3D_3$	7.573	2.36[04]
$3s4s\ ^3S_1$	8.473	5.68[04]	$3p4f\ ^1D_2$	8.409	9.58[10]			
$3s4d\ ^3D_1$	7.607	1.95[04]	$3p4f\ ^3F_2$	7.845	5.90[10]			
			$3s4d\ ^3D_2$	7.603	9.32[09]			
			$3s4d\ ^1D_2$	7.570	2.36[10]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=61$ , odd-parity states								
$3d4p\ ^3P_1$	12.638	1.55[12]	$3d4p\ ^3F_2$	13.006	4.62[05]	$3d4p\ ^3F_3$	12.992	4.18[05]
$3d4p\ ^3D_1$	12.493	4.73[12]	$3d4p\ ^3P_2$	12.665	1.90[03]	$3d4p\ ^1F_3$	12.476	3.91[05]
$3d4p\ ^1P_1$	12.195	5.87[11]	$3d4p\ ^1D_2$	12.502	1.43[06]	$3d4p\ ^3D_3$	12.195	5.82[05]
$3d4f\ ^3P_1$	10.295	8.42[12]	$3d4p\ ^3D_2$	12.172	3.31[03]	$3d4f\ ^3D_3$	10.155	8.13[06]
$3d4f\ ^3D_1$	10.203	3.90[11]	$3d4f\ ^3P_2$	10.313	5.27[06]	$3d4f\ ^3G_3$	10.126	2.15[05]
$3d4f\ ^1P_1$	10.082	1.76[13]	$3d4f\ ^3D_2$	10.178	5.74[07]	$3d4f\ ^3F_3$	9.934	3.93[06]
$3p4s\ ^1P_1$	9.816	1.26[14]	$3d4f\ ^1D_2$	10.156	5.14[07]	$3d4f\ ^1F_3$	9.928	1.97[02]
$3p4s\ ^3P_1$	9.384	1.46[12]	$3d4f\ ^3F_2$	9.970	1.03[06]	$3p4d\ ^3F_3$	8.769	1.12[07]
$3p4d\ ^3P_1$	8.774	2.63[11]	$3p4s\ ^3P_2$	9.951	1.85[07]	$3p4d\ ^1F_3$	8.702	4.90[06]
$3p4d\ ^1P_1$	8.713	2.86[13]	$3p4d\ ^3F_2$	8.755	8.06[05]	$3p4d\ ^3D_3$	8.047	1.10[07]
$3p4d\ ^3D_1$	8.091	1.68[13]	$3p4d\ ^3P_2$	8.716	2.45[07]	$3s4f\ ^3F_3$	6.791	1.64[08]
$3s4p\ ^3P_1$	7.925	4.25[12]	$3p4d\ ^3D_2$	8.091	3.74[05]	$3s4f\ ^1F_3$	6.777	6.96[06]
$3s4p\ ^1P_1$	7.743	5.49[12]	$3p4d\ ^1D_2$	8.055	4.26[06]			
			$3s4p\ ^3P_2$	7.748	3.72[06]			
			$3s4f\ ^3F_2$	6.793	3.11[03]			



level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=61$ , even-parity states								
$3d4s\ ^3D_1$	13.601	9.26[02]	$3d4s\ ^3D_2$	13.971	8.58[08]	$3d4s\ ^3D_3$	13.991	4.42[02]
$3d4d\ ^3S_1$	11.334	5.58[06]	$3d4s\ ^1D_2$	13.587	7.11[08]	$3d4d\ ^3G_3$	11.269	1.92[02]
$3d4d\ ^1P_1$	11.236	1.19[06]	$3d4d\ ^3P_2$	11.286	4.37[08]	$3d4d\ ^3D_3$	11.198	4.63[03]
$3d4d\ ^3D_1$	11.047	1.75[06]	$3d4d\ ^3D_2$	11.188	3.95[09]	$3d4d\ ^3F_3$	11.042	1.52[02]
$3d4d\ ^3P_1$	10.982	1.94[06]	$3d4d\ ^3F_2$	11.003	2.81[09]	$3d4d\ ^1F_3$	10.937	8.74[00]
$3p4p\ ^3D_1$	9.768	3.61[07]	$3d4d\ ^1D_2$	10.950	1.24[09]	$3p4p\ ^3D_3$	9.492	8.35[03]
$3p4p\ ^3S_1$	9.491	6.95[05]	$3p4p\ ^3D_2$	9.758	5.38[09]	$3p4f\ ^3D_3$	8.071	8.66[04]
$3p4p\ ^1P_1$	8.936	2.81[05]	$3p4p\ ^1D_2$	9.464	5.22[09]	$3p4f\ ^3G_3$	8.063	4.23[04]
$3p4p\ ^3P_1$	8.706	3.53[07]	$3p4p\ ^3P_2$	8.697	7.22[09]	$3p4f\ ^3F_3$	7.493	6.47[04]
$3p4f\ ^3D_1$	8.292	2.18[06]	$3p4f\ ^3D_2$	8.087	4.08[09]	$3s4d\ ^3D_3$	7.231	3.24[04]
$3s4s\ ^3S_1$	8.104	6.94[04]	$3p4f\ ^1D_2$	8.043	1.13[11]			
$3s4d\ ^3D_1$	7.265	8.99[02]	$3p4f\ ^3F_2$	7.483	6.66[10]			
			$3s4d\ ^3D_2$	7.261	1.13[10]			
			$3s4d\ ^1D_2$	7.228	2.76[10]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=62$ , odd-parity states								
$3d4p\ ^3P_1$	12.015	1.81[12]	$3d4p\ ^3F_2$	12.376	5.51[05]	$3d4p\ ^3F_3$	12.362	5.10[05]
$3d4p\ ^3D_1$	11.871	5.09[12]	$3d4p\ ^3P_2$	12.041	3.34[03]	$3d4p\ ^1F_3$	11.855	4.83[05]
$3d4p\ ^1P_1$	11.579	6.57[11]	$3d4p\ ^1D_2$	11.879	1.74[06]	$3d4p\ ^3D_3$	11.578	7.30[05]
$3d4f\ ^3P_1$	9.840	9.16[12]	$3d4p\ ^3D_2$	11.557	3.75[03]	$3d4f\ ^3D_3$	9.686	9.70[06]
$3d4f\ ^3D_1$	9.731	3.82[11]	$3d4f\ ^3P_2$	9.857	5.73[06]	$3d4f\ ^3G_3$	9.657	3.61[05]
$3d4f\ ^1P_1$	9.613	2.12[13]	$3d4f\ ^3D_2$	9.707	6.67[07]	$3d4f\ ^3F_3$	9.467	4.85[06]
$3p4s\ ^1P_1$	9.358	1.41[14]	$3d4f\ ^1D_2$	9.686	6.65[07]	$3d4f\ ^1F_3$	9.462	1.69[03]
$3p4s\ ^3P_1$	8.941	1.63[12]	$3d4f\ ^3F_2$	9.502	1.14[06]	$3p4d\ ^3F_3$	8.387	1.33[07]
$3p4d\ ^3P_1$	8.393	3.51[11]	$3p4s\ ^3P_2$	9.484	2.30[07]	$3p4d\ ^1F_3$	8.322	6.01[06]
$3p4d\ ^1P_1$	8.332	3.22[13]	$3p4d\ ^3F_2$	8.374	8.29[05]	$3p4d\ ^3D_3$	7.674	1.35[07]
$3p4d\ ^3D_1$	7.718	1.93[13]	$3p4d\ ^3P_2$	8.335	2.93[07]	$3s4f\ ^3F_3$	6.495	1.85[08]
$3s4p\ ^3P_1$	7.574	2.96[12]	$3p4d\ ^3D_2$	7.717	4.69[05]	$3s4f\ ^1F_3$	6.480	7.91[06]
$3s4p\ ^1P_1$	7.395	6.05[12]	$3p4d\ ^1D_2$	7.682	5.26[06]			
			$3s4p\ ^3P_2$	7.399	4.53[06]			
			$3s4f\ ^3F_2$	6.497	3.82[03]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=62$ , even-parity states								
$3d4s\ ^3D_1$	12.912	1.19[03]	$3d4s\ ^3D_2$	13.276	1.01[09]	$3d4s\ ^3D_3$	13.294	5.76[02]
$3d4d\ ^3S_1$	10.792	6.95[06]	$3d4s\ ^1D_2$	12.899	8.31[08]	$3d4d\ ^3G_3$	10.731	2.32[02]
$3d4d\ ^1P_1$	10.696	1.62[06]	$3d4d\ ^3P_2$	10.747	5.39[08]	$3d4d\ ^3D_3$	10.661	6.02[03]
$3d4d\ ^3D_1$	10.511	2.09[06]	$3d4d\ ^3D_2$	10.651	4.62[09]	$3d4d\ ^3F_3$	10.507	1.89[02]
$3d4d\ ^3P_1$	10.446	2.41[06]	$3d4d\ ^3F_2$	10.470	3.26[09]	$3d4d\ ^1F_3$	10.404	1.29[01]
$3p4p\ ^3D_1$	9.343	4.46[07]	$3d4d\ ^1D_2$	10.416	1.43[09]	$3p4p\ ^3D_3$	9.067	1.07[04]
$3p4p\ ^3S_1$	9.067	9.60[05]	$3p4p\ ^3D_2$	9.334	6.19[09]	$3p4f\ ^3D_3$	7.725	9.00[04]
$3p4p\ ^1P_1$	8.521	3.51[05]	$3p4p\ ^1D_2$	9.042	6.04[09]	$3p4f\ ^3G_3$	7.719	6.47[04]
$3p4p\ ^3P_1$	8.293	4.35[07]	$3p4p\ ^3P_2$	8.284	8.58[09]	$3p4f\ ^3F_3$	7.153	8.79[04]
$3p4f\ ^3D_1$	7.920	2.70[06]	$3p4f\ ^3D_2$	7.741	4.18[09]	$3s4d\ ^3D_3$	6.910	4.26[04]
$3s4s\ ^3S_1$	7.758	8.11[04]	$3p4f\ ^1D_2$	7.698	1.27[11]			
$3s4d\ ^3D_1$	6.944	1.12[03]	$3p4f\ ^3F_2$	7.144	7.37[10]			
			$3s4d\ ^3D_2$	6.941	1.24[10]			
			$3s4d\ ^1D_2$	6.908	3.13[10]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=63$ , odd-parity states								
$3d4p\ ^3P_1$	11.439	2.07[12]	$3d4p\ ^3F_2$	11.792	6.63[05]	$3d4p\ ^3F_3$	11.780	6.19[05]
$3d4p\ ^3D_1$	11.296	5.54[12]	$3d4p\ ^3P_2$	11.463	5.22[03]	$3d4p\ ^1F_3$	11.280	5.93[05]
$3d4p\ ^1P_1$	11.008	7.02[11]	$3d4p\ ^1D_2$	11.303	2.12[06]	$3d4p\ ^3D_3$	11.007	9.08[05]
$3d4f\ ^3P_1$	9.415	9.87[12]	$3d4p\ ^3D_2$	10.988	3.99[03]	$3d4f\ ^3D_3$	9.249	1.15[07]
$3d4f\ ^3D_1$	9.291	3.60[11]	$3d4f\ ^3P_2$	9.431	6.49[06]	$3d4f\ ^3G_3$	9.221	5.81[05]
$3d4f\ ^1P_1$	9.177	2.50[13]	$3d4f\ ^3D_2$	9.268	7.66[07]	$3d4f\ ^3F_3$	9.033	5.94[06]
$3p4s\ ^1P_1$	8.931	1.55[14]	$3d4f\ ^1D_2$	9.249	8.55[07]	$3d4f\ ^1F_3$	9.029	1.18[04]
$3p4s\ ^3P_1$	8.527	1.74[12]	$3d4f\ ^3F_2$	9.066	1.22[06]	$3p4d\ ^3F_3$	8.030	1.58[07]
$3p4d\ ^3P_1$	8.036	5.13[11]	$3p4s\ ^3P_2$	9.049	2.86[07]	$3p4d\ ^1F_3$	7.966	7.33[06]
$3p4d\ ^1P_1$	7.976	3.52[13]	$3p4d\ ^3F_2$	8.018	8.47[05]	$3p4d\ ^3D_3$	7.324	1.64[07]
$3p4d\ ^3D_1$	7.370	2.14[13]	$3p4d\ ^3P_2$	7.979	3.57[07]	$3s4f\ ^3F_3$	6.217	2.16[08]
$3s4p\ ^3P_1$	7.244	2.75[12]	$3p4d\ ^3D_2$	7.368	5.69[05]	$3s4f\ ^1F_3$	6.203	9.02[06]
$3s4p\ ^1P_1$	7.066	7.48[12]	$3p4d\ ^1D_2$	7.332	6.41[06]			
			$3s4p\ ^3P_2$	7.070	5.46[06]			
			$3s4f\ ^3F_2$	6.220	4.64[03]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=63$ , even-parity states								
$3d4s\ ^3D_1$	12.276	1.57[03]	$3d4s\ ^3D_2$	12.634	1.19[09]	$3d4s\ ^3D_3$	12.651	7.44[02]
$3d4d\ ^3S_1$	10.288	8.62[06]	$3d4s\ ^1D_2$	12.264	9.70[08]	$3d4d\ ^3G_3$	10.233	2.77[02]
$3d4d\ ^1P_1$	10.194	2.17[06]	$3d4d\ ^3P_2$	10.247	6.65[08]	$3d4d\ ^3D_3$	10.162	7.74[03]
$3d4d\ ^3D_1$	10.013	2.50[06]	$3d4d\ ^3D_2$	10.153	5.40[09]	$3d4d\ ^3F_3$	10.010	2.35[02]
$3d4d\ ^3P_1$	9.949	2.98[06]	$3d4d\ ^3F_2$	9.976	3.76[09]	$3d4d\ ^1F_3$	9.909	1.96[01]
$3p4p\ ^3D_1$	8.945	5.49[07]	$3d4d\ ^1D_2$	9.920	1.66[09]	$3p4p\ ^3D_3$	8.671	1.35[04]
$3p4p\ ^3S_1$	8.670	1.30[06]	$3p4p\ ^3D_2$	8.937	7.12[09]	$3p4f\ ^3D_3$	7.404	9.65[04]
$3p4p\ ^1P_1$	8.133	4.50[05]	$3p4p\ ^1D_2$	8.647	6.97[09]	$3p4f\ ^3G_3$	7.394	7.60[04]
$3p4p\ ^3P_1$	7.907	5.34[07]	$3p4p\ ^3P_2$	7.897	9.14[09]	$3p4f\ ^3F_3$	6.834	1.22[05]
$3p4f\ ^3D_1$	7.571	3.41[06]	$3p4f\ ^3D_2$	7.419	4.29[09]	$3s4d\ ^3D_3$	6.609	5.60[04]
$3s4s\ ^3S_1$	7.434	1.38[05]	$3p4f\ ^1D_2$	7.377	1.42[11]			
$3s4d\ ^3D_1$	6.643	1.32[03]	$3p4f\ ^3F_2$	6.827	7.98[10]			
			$3s4d\ ^3D_2$	6.640	1.45[10]			
			$3s4d\ ^1D_2$	6.607	3.56[10]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=64$ , odd-parity states								
$3d4p\ ^3P_1$	10.904	2.35[12]	$3d4p\ ^3F_2$	11.251	7.95[05]	$3d4p\ ^3F_3$	11.240	7.47[05]
$3d4p\ ^3D_1$	10.761	6.02[12]	$3d4p\ ^3P_2$	10.927	7.74[03]	$3d4p\ ^1F_3$	10.747	7.24[05]
$3d4p\ ^1P_1$	10.479	7.50[11]	$3d4p\ ^1D_2$	10.768	2.57[06]	$3d4p\ ^3D_3$	10.478	1.12[06]
$3d4f\ ^3P_1$	9.018	1.07[13]	$3d4p\ ^3D_2$	10.460	4.22[03]	$3d4f\ ^3D_3$	8.841	1.35[07]
$3d4f\ ^3D_1$	8.881	3.47[11]	$3d4f\ ^3P_2$	9.033	7.44[06]	$3d4f\ ^3G_3$	8.814	9.05[05]
$3d4f\ ^1P_1$	8.771	2.94[13]	$3d4f\ ^3D_2$	8.859	8.67[07]	$3d4f\ ^3F_3$	8.628	7.22[06]
$3p4s\ ^1P_1$	8.534	1.70[14]	$3d4f\ ^1D_2$	8.841	1.09[08]	$3d4f\ ^1F_3$	8.624	3.63[04]
$3p4s\ ^3P_1$	8.140	1.90[12]	$3d4f\ ^3F_2$	8.659	1.24[06]	$3p4d\ ^3F_3$	7.696	1.87[07]
$3p4d\ ^3P_1$	7.701	7.00[11]	$3p4s\ ^3P_2$	8.644	3.52[07]	$3p4d\ ^1F_3$	7.633	8.90[06]
$3p4d\ ^1P_1$	7.642	3.87[13]	$3p4d\ ^3F_2$	7.685	8.65[05]	$3p4d\ ^3D_3$	6.997	1.99[07]
$3p4d\ ^3D_1$	7.043	2.39[13]	$3p4d\ ^3P_2$	7.645	4.32[07]	$3s4f\ ^3F_3$	5.957	2.53[08]
$3s4p\ ^3P_1$	6.935	2.55[12]	$3p4d\ ^3D_2$	7.040	6.95[05]	$3s4f\ ^1F_3$	5.943	1.30[07]
$3s4p\ ^1P_1$	6.758	1.04[13]	$3p4d\ ^1D_2$	7.004	7.96[06]			
			$3s4p\ ^3P_2$	6.762	6.59[06]			
			$3s4f\ ^3F_2$	5.959	5.03[03]			

level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=64$ , even-parity states								
$3d4s\ ^3D_1$	11.687	1.92[03]	$3d4s\ ^3D_2$	12.039	1.39[09]	$3d4s\ ^3D_3$	12.055	9.55[02]
$3d4d\ ^3S_1$	9.820	1.06[07]	$3d4s\ ^1D_2$	11.676	1.11[09]	$3d4d\ ^3G_3$	9.768	3.34[02]
$3d4d\ ^1P_1$	9.728	2.90[06]	$3d4d\ ^3P_2$	9.781	8.09[08]	$3d4d\ ^3D_3$	9.697	9.93[03]
$3d4d\ ^3D_1$	9.550	2.96[06]	$3d4d\ ^3D_2$	9.689	6.27[09]	$3d4d\ ^3F_3$	9.547	2.91[02]
$3d4d\ ^3P_1$	9.486	3.67[06]	$3d4d\ ^3F_2$	9.515	4.33[09]	$3d4d\ ^1F_3$	9.449	2.78[01]
$3p4p\ ^3D_1$	8.574	6.72[07]	$3d4d\ ^1D_2$	9.460	1.86[09]	$3p4p\ ^3D_3$	8.300	1.71[04]
$3p4p\ ^3S_1$	8.299	1.75[06]	$3p4p\ ^3D_2$	8.566	8.18[09]	$3p4f\ ^3D_3$	7.101	1.01[05]
$3p4p\ ^1P_1$	7.770	5.37[05]	$3p4p\ ^1D_2$	8.277	7.97[09]	$3p4f\ ^3G_3$	7.095	1.16[05]
$3p4p\ ^3P_1$	7.545	6.55[07]	$3p4p\ ^3P_2$	7.539	9.99[09]	$3p4f\ ^3F_3$	6.535	1.70[05]
$3p4f\ ^3D_1$	7.244	4.36[06]	$3p4f\ ^3D_2$	7.115	4.42[09]	$3s4d\ ^3D_3$	6.326	7.18[04]
$3s4s\ ^3S_1$	7.130	2.45[05]	$3p4f\ ^1D_2$	7.075	1.69[11]			
$3s4d\ ^3D_1$	6.360	2.52[03]	$3p4f\ ^3F_2$	6.529	8.31[10]			
			$3s4d\ ^3D_2$	6.357	1.97[10]			
			$3s4d\ ^1D_2$	6.324	4.15[10]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=65$ , odd-parity states								
$3d4p\ ^3P_1$	10.408	2.65[12]	$3d4p\ ^3F_2$	10.749	9.51[05]	$3d4p\ ^3F_3$	10.738	8.97[05]
$3d4p\ ^3D_1$	10.265	6.53[12]	$3d4p\ ^3P_2$	10.430	1.14[04]	$3d4p\ ^1F_3$	10.252	8.80[05]
$3d4p\ ^1P_1$	9.986	8.00[11]	$3d4p\ ^1D_2$	10.272	3.10[06]	$3d4p\ ^3D_3$	9.986	1.38[06]
$3d4f\ ^3P_1$	8.646	1.15[13]	$3d4p\ ^3D_2$	9.969	4.42[03]	$3d4f\ ^3D_3$	8.461	1.58[07]
$3d4f\ ^3D_1$	8.499	3.37[11]	$3d4f\ ^3P_2$	8.661	8.60[06]	$3d4f\ ^3G_3$	8.434	1.37[06]
$3d4f\ ^1P_1$	8.392	3.44[13]	$3d4f\ ^3D_2$	8.478	9.70[07]	$3d4f\ ^3F_3$	8.251	8.73[06]
$3p4s\ ^1P_1$	8.163	1.86[14]	$3d4f\ ^1D_2$	8.460	1.39[08]	$3d4f\ ^1F_3$	8.247	8.29[04]
$3p4s\ ^3P_1$	7.777	2.05[12]	$3d4f\ ^3F_2$	8.279	1.16[06]	$3p4d\ ^3F_3$	7.382	2.21[07]
$3p4d\ ^3P_1$	7.386	9.40[11]	$3p4s\ ^3P_2$	8.265	4.34[07]	$3p4d\ ^1F_3$	7.320	1.08[07]
$3p4d\ ^1P_1$	7.328	4.23[13]	$3p4d\ ^3F_2$	7.371	8.89[05]	$3p4d\ ^3D_3$	6.690	2.40[07]
$3p4d\ ^3D_1$	6.737	2.66[13]	$3p4d\ ^3P_2$	7.331	5.22[07]	$3s4f\ ^3F_3$	5.712	2.93[08]
$3s4p\ ^3P_1$	6.644	2.34[12]	$3p4d\ ^3D_2$	6.733	8.30[05]	$3s4f\ ^1F_3$	5.699	1.88[07]
$3s4p\ ^1P_1$	6.467	2.16[13]	$3p4d\ ^1D_2$	6.697	9.65[06]			
			$3s4p\ ^3P_2$	6.472	7.88[06]			
			$3s4f\ ^3F_2$	5.715	7.22[03]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=65$ , even-parity states								
$3d4s\ ^3D_1$	11.141	2.42[03]	$3d4s\ ^3D_2$	11.488	1.61[09]	$3d4s\ ^3D_3$	11.504	1.21[03]
$3d4d\ ^3S_1$	9.383	1.30[07]	$3d4s\ ^1D_2$	11.131	1.28[09]	$3d4d\ ^3G_3$	9.335	3.97[02]
$3d4d\ ^1P_1$	9.293	3.82[06]	$3d4d\ ^3P_2$	9.347	9.75[08]	$3d4d\ ^3D_3$	9.264	1.26[04]
$3d4d\ ^3D_1$	9.119	3.50[06]	$3d4d\ ^3D_2$	9.257	7.24[09]	$3d4d\ ^3F_3$	9.116	3.58[02]
$3d4d\ ^3P_1$	9.055	4.48[06]	$3d4d\ ^3F_2$	9.086	4.97[09]	$3d4d\ ^1F_3$	9.020	3.89[01]
$3p4p\ ^3D_1$	8.225	8.20[07]	$3d4d\ ^1D_2$	9.030	2.14[09]	$3p4p\ ^3D_3$	7.952	2.13[04]
$3p4p\ ^3S_1$	7.951	2.32[06]	$3p4p\ ^3D_2$	8.218	9.30[09]	$3p4f\ ^3D_3$	6.816	1.11[05]
$3p4p\ ^1P_1$	7.429	6.61[05]	$3p4p\ ^1D_2$	7.931	9.10[09]	$3p4f\ ^3G_3$	6.811	1.66[05]
$3p4p\ ^3P_1$	7.207	7.98[07]	$3p4p\ ^3P_2$	7.199	1.11[10]	$3p4f\ ^3F_3$	6.252	2.46[05]
$3p4f\ ^3D_1$	6.937	5.61[06]	$3p4f\ ^3D_2$	6.830	4.67[09]	$3s4d\ ^3D_3$	6.060	9.20[04]
$3s4s\ ^3S_1$	6.845	3.13[05]	$3p4f\ ^1D_2$	6.791	1.91[11]			
$3s4d\ ^3D_1$	6.094	3.59[03]	$3p4f\ ^3F_2$	6.248	9.74[10]			
			$3s4d\ ^3D_2$	6.091	2.18[10]			
			$3s4d\ ^1D_2$	6.058	4.84[10]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=66$ , odd-parity states								
$3d4p\ ^3P_1$	9.946	2.95[12]	$3d4p\ ^3F_2$	10.281	1.14[06]	$3d4p\ ^3F_3$	10.271	1.07[06]
$3d4p\ ^3D_1$	9.803	7.10[12]	$3d4p\ ^3P_2$	9.966	1.56[04]	$3d4p\ ^1F_3$	9.790	1.06[06]
$3d4p\ ^1P_1$	9.528	7.43[11]	$3d4p\ ^1D_2$	9.809	3.74[06]	$3d4p\ ^3D_3$	9.527	1.69[06]
$3d4f\ ^3P_1$	8.298	1.23[13]	$3d4p\ ^3D_2$	9.512	4.66[03]	$3d4f\ ^3D_3$	8.105	1.83[07]
$3d4f\ ^3D_1$	8.141	3.18[11]	$3d4f\ ^3P_2$	8.312	1.01[07]	$3d4f\ ^3G_3$	8.079	2.03[06]
$3d4f\ ^1P_1$	8.037	3.98[13]	$3d4f\ ^3D_2$	8.120	1.07[08]	$3d4f\ ^3F_3$	7.897	1.05[07]
$3p4s\ ^1P_1$	7.815	2.02[14]	$3d4f\ ^1D_2$	8.103	1.75[08]	$3d4f\ ^1F_3$	7.893	1.63[05]
$3p4s\ ^3P_1$	7.438	2.32[12]	$3d4f\ ^3F_2$	7.924	1.00[06]	$3p4d\ ^3F_3$	7.087	2.59[07]
$3p4d\ ^3P_1$	7.091	1.35[12]	$3p4s\ ^3P_2$	7.911	5.30[07]	$3p4d\ ^1F_3$	7.025	1.29[07]
$3p4d\ ^1P_1$	7.034	4.73[13]	$3p4d\ ^3F_2$	7.077	9.09[05]	$3p4d\ ^3D_3$	6.401	2.89[07]
$3p4d\ ^3D_1$	6.449	2.95[13]	$3p4d\ ^3P_2$	7.036	6.34[07]	$3s4f\ ^3F_3$	5.480	3.08[08]
$3s4p\ ^3P_1$	6.369	2.28[12]	$3p4d\ ^3D_2$	6.444	9.35[05]	$3s4f\ ^1F_3$	5.466	2.37[07]
$3s4p\ ^1P_1$	6.192	4.62[13]	$3p4d\ ^1D_2$	6.408	1.18[07]			
			$3s4p\ ^3P_2$	6.199	9.47[06]			
			$3s4f\ ^3F_2$	5.481	8.90[03]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=66$ , even-parity states								
$3d4s\ ^3D_1$	10.634	3.04[03]	$3d4s\ ^3D_2$	10.977	1.87[09]	$3d4s\ ^3D_3$	10.991	1.54[03]
$3d4d\ ^3S_1$	8.976	1.59[07]	$3d4s\ ^1D_2$	10.625	1.48[09]	$3d4d\ ^3G_3$	8.931	4.76[02]
$3d4d\ ^1P_1$	8.888	4.98[06]	$3d4d\ ^3P_2$	8.942	1.17[09]	$3d4d\ ^3D_3$	8.860	1.60[04]
$3d4d\ ^3D_1$	8.717	4.14[06]	$3d4d\ ^3D_2$	8.853	8.34[09]	$3d4d\ ^3F_3$	8.714	4.39[02]
$3d4d\ ^3P_1$	8.652	5.44[06]	$3d4d\ ^3F_2$	8.686	5.67[09]	$3d4d\ ^1F_3$	8.620	5.64[01]
$3p4p\ ^3D_1$	7.898	9.97[07]	$3d4d\ ^1D_2$	8.629	2.46[09]	$3p4p\ ^3D_3$	7.625	2.68[04]
$3p4p\ ^3S_1$	7.625	3.03[06]	$3p4p\ ^3D_2$	7.892	1.05[10]	$3p4f\ ^3D_3$	6.549	1.18[05]
$3p4p\ ^1P_1$	7.110	8.10[05]	$3p4p\ ^1D_2$	7.605	1.04[10]	$3p4f\ ^3G_3$	6.544	2.30[05]
$3p4p\ ^3P_1$	6.889	9.69[07]	$3p4p\ ^3P_2$	6.882	1.33[10]	$3p4f\ ^3F_3$	5.983	4.08[05]
$3p4f\ ^3D_1$	6.647	7.24[06]	$3p4f\ ^3D_2$	6.562	4.94[09]	$3s4d\ ^3D_3$	5.809	1.04[05]
$3s4s\ ^3S_1$	6.576	3.80[05]	$3p4f\ ^1D_2$	6.524	2.17[11]			
$3s4d\ ^3D_1$	5.842	4.99[03]	$3p4f\ ^3F_2$	5.980	1.04[11]			
			$3s4d\ ^3D_2$	5.840	2.42[10]			
			$3s4d\ ^1D_2$	5.807	5.54[10]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=67$ , odd-parity states								
$3d4p\ ^3P_1$	9.515	3.32[12]	$3d4p\ ^3F_2$	9.845	1.31[06]	$3d4p\ ^3F_3$	9.836	1.27[06]
$3d4p\ ^3D_1$	9.372	7.64[12]	$3d4p\ ^3P_2$	9.534	2.28[04]	$3d4p\ ^1F_3$	9.360	1.28[06]
$3d4p\ ^1P_1$	9.102	6.84[11]	$3d4p\ ^1D_2$	9.378	4.40[06]	$3d4p\ ^3D_3$	9.100	2.05[06]
$3d4f\ ^3P_1$	7.971	1.27[13]	$3d4p\ ^3D_2$	9.086	4.85[03]	$3d4f\ ^3D_3$	7.771	2.12[07]
$3d4f\ ^3D_1$	7.797	1.64[11]	$3d4f\ ^3P_2$	7.983	1.10[07]	$3d4f\ ^3G_3$	7.746	2.92[06]
$3d4f\ ^1P_1$	7.714	4.23[13]	$3d4f\ ^3D_2$	7.783	1.17[08]	$3d4f\ ^3F_3$	7.566	1.25[07]
$3p4s\ ^1P_1$	7.496	2.20[14]	$3d4f\ ^1D_2$	7.770	2.20[08]	$3d4f\ ^1F_3$	7.562	2.83[05]
$3p4s\ ^3P_1$	7.120	2.62[12]	$3d4f\ ^3F_2$	7.591	6.97[05]	$3p4d\ ^3F_3$	6.810	3.05[07]
$3p4d\ ^3P_1$	6.816	1.49[12]	$3p4s\ ^3P_2$	7.579	6.44[07]	$3p4d\ ^1F_3$	6.748	1.55[07]
$3p4d\ ^1P_1$	6.756	5.28[13]	$3p4d\ ^3F_2$	6.801	9.24[05]	$3p4d\ ^3D_3$	6.130	3.45[07]
$3p4d\ ^3D_1$	6.179	3.30[13]	$3p4d\ ^3P_2$	6.758	7.20[07]	$3s4f\ ^3F_3$	5.261	4.15[08]
$3s4p\ ^3P_1$	6.110	4.05[12]	$3p4d\ ^3D_2$	6.172	1.03[06]	$3s4f\ ^1F_3$	5.249	3.16[07]
$3s4p\ ^1P_1$	5.929	4.50[13]	$3p4d\ ^1D_2$	6.136	1.43[07]			
			$3s4p\ ^3P_2$	5.934	1.36[06]			
			$3s4f\ ^3F_2$	5.264	1.05[04]			

level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=67$ , even-parity states								
$3d4s\ ^3D_1$	10.162	3.81[03]	$3d4s\ ^3D_2$	10.500	2.14[09]	$3d4s\ ^3D_3$	10.513	1.94[03]
$3d4d\ ^3S_1$	8.595	1.94[07]	$3d4s\ ^1D_2$	10.153	1.69[09]	$3d4d\ ^3G_3$	8.553	5.69[02]
$3d4d\ ^1P_1$	8.508	6.43[06]	$3d4d\ ^3P_2$	8.564	1.37[09]	$3d4d\ ^3D_3$	8.482	2.01[04]
$3d4d\ ^3D_1$	8.340	4.88[06]	$3d4d\ ^3D_2$	8.476	9.54[09]	$3d4d\ ^3F_3$	8.338	5.36[02]
$3d4d\ ^3P_1$	8.276	6.57[06]	$3d4d\ ^3F_2$	8.311	6.33[09]	$3d4d\ ^1F_3$	8.245	8.51[01]
$3p4p\ ^3D_1$	7.591	1.21[08]	$3d4d\ ^1D_2$	8.254	2.83[09]	$3p4p\ ^3D_3$	7.319	3.34[04]
$3p4p\ ^3S_1$	7.318	3.92[06]	$3p4p\ ^3D_2$	7.586	1.25[10]	$3p4f\ ^3D_3$	6.297	1.24[05]
$3p4p\ ^1P_1$	6.810	9.89[05]	$3p4p\ ^1D_2$	7.300	1.17[10]	$3p4f\ ^3G_3$	6.292	3.15[05]
$3p4p\ ^3P_1$	6.591	1.17[08]	$3p4p\ ^3P_2$	6.583	1.55[10]	$3p4f\ ^3F_3$	5.749	8.96[05]
$3p4f\ ^3D_1$	6.375	9.38[06]	$3p4f\ ^3D_2$	6.310	4.88[09]	$3s4d\ ^3D_3$	5.572	1.76[05]
$3s4s\ ^3S_1$	6.323	4.50[05]	$3p4f\ ^1D_2$	6.273	2.50[11]			
$3s4d\ ^3D_1$	5.606	6.75[03]	$3p4f\ ^3F_2$	5.744	1.34[11]			
			$3s4d\ ^3D_2$	5.603	2.79[10]			
			$3s4d\ ^1D_2$	5.570	6.33[10]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=68$ , odd-parity states								
$3d4p\ ^3P_1$	9.112	3.74[12]	$3d4p\ ^3F_2$	9.437	1.57[06]	$3d4p\ ^3F_3$	9.429	1.51[06]
$3d4p\ ^3D_1$	8.969	8.19[12]	$3d4p\ ^3P_2$	9.131	3.20[04]	$3d4p\ ^1F_3$	8.958	1.54[06]
$3d4p\ ^1P_1$	8.702	9.97[11]	$3d4p\ ^1D_2$	8.975	5.27[06]	$3d4p\ ^3D_3$	8.701	2.48[06]
$3d4f\ ^3P_1$	7.663	1.44[13]	$3d4p\ ^3D_2$	8.687	5.07[03]	$3d4f\ ^3D_3$	7.458	2.42[07]
$3d4f\ ^3D_1$	7.491	3.34[11]	$3d4f\ ^3P_2$	7.676	1.31[07]	$3d4f\ ^3G_3$	7.433	4.12[06]
$3d4f\ ^1P_1$	7.393	5.41[13]	$3d4f\ ^3D_2$	7.472	1.26[08]	$3d4f\ ^3F_3$	7.256	1.49[07]
$3p4s\ ^1P_1$	7.184	2.41[14]	$3d4f\ ^1D_2$	7.456	2.73[08]	$3d4f\ ^1F_3$	7.251	4.65[05]
$3p4s\ ^3P_1$	6.819	2.99[12]	$3d4f\ ^3F_2$	7.279	3.72[05]	$3p4d\ ^3F_3$	6.548	3.56[07]
$3p4d\ ^3P_1$	6.551	1.59[12]	$3p4s\ ^3P_2$	7.267	7.83[07]	$3p4d\ ^1F_3$	6.487	1.85[07]
$3p4d\ ^1P_1$	6.495	5.85[13]	$3p4d\ ^3F_2$	6.539	9.47[05]	$3p4d\ ^3D_3$	5.873	4.11[07]
$3p4d\ ^3D_1$	5.924	3.69[13]	$3p4d\ ^3P_2$	6.497	8.70[07]	$3s4f\ ^3F_3$	5.054	4.72[08]
$3s4p\ ^3P_1$	5.865	5.87[12]	$3p4d\ ^3D_2$	5.915	1.26[06]	$3s4f\ ^1F_3$	5.042	4.48[07]
$3s4p\ ^1P_1$	5.698	4.42[13]	$3p4d\ ^1D_2$	5.880	1.72[07]			
			$3s4p\ ^3P_2$	5.700	4.15[06]			
			$3s4f\ ^3F_2$	5.056	1.58[04]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=68$ , even-parity states								
$3d4s\ ^3D_1$	9.722	4.75[03]	$3d4s\ ^3D_2$	10.056	2.53[09]	$3d4s\ ^3D_3$	10.069	2.49[03]
$3d4d\ ^3S_1$	8.239	2.35[07]	$3d4s\ ^1D_2$	9.714	1.96[09]	$3d4d\ ^3G_3$	8.199	7.66[02]
$3d4d\ ^1P_1$	8.153	8.23[06]	$3d4d\ ^3P_2$	8.209	1.71[09]	$3d4d\ ^3D_3$	8.128	2.59[04]
$3d4d\ ^3D_1$	7.988	5.73[06]	$3d4d\ ^3D_2$	8.122	1.11[10]	$3d4d\ ^3F_3$	7.986	6.85[02]
$3d4d\ ^3P_1$	7.924	7.89[06]	$3d4d\ ^3F_2$	7.961	7.91[09]	$3d4d\ ^1F_3$	7.894	1.15[02]
$3p4p\ ^3D_1$	7.302	1.46[08]	$3d4d\ ^1D_2$	7.903	3.02[09]	$3p4p\ ^3D_3$	7.030	4.51[04]
$3p4p\ ^3S_1$	7.030	5.02[06]	$3p4p\ ^3D_2$	7.297	1.42[10]	$3p4f\ ^3D_3$	6.059	1.21[05]
$3p4p\ ^1P_1$	6.527	1.20[06]	$3p4p\ ^1D_2$	7.012	1.38[10]	$3p4f\ ^3G_3$	6.055	4.93[05]
$3p4p\ ^3P_1$	6.310	1.41[08]	$3p4p\ ^3P_2$	6.303	1.84[10]	$3p4f\ ^3F_3$	5.514	3.26[07]
$3p4f\ ^3D_1$	6.118	1.22[07]	$3p4f\ ^3D_2$	6.071	4.55[09]	$3s4d\ ^3D_3$	5.348	2.61[05]
$3s4s\ ^3S_1$	6.084	5.16[05]	$3p4f\ ^1D_2$	6.036	2.59[11]			
$3s4d\ ^3D_1$	5.382	8.88[03]	$3p4f\ ^3F_2$	5.510	1.61[11]			
			$3s4d\ ^3D_2$	5.379	3.08[10]			
			$3s4d\ ^1D_2$	5.346	7.32[10]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=69$ , odd-parity states								
$3d4p\ ^3P_1$	8.736	4.14[12]	$3d4p\ ^3F_2$	9.056	1.85[06]	$3d4p\ ^3F_3$	9.049	1.78[06]
$3d4p\ ^3D_1$	8.592	8.84[12]	$3d4p\ ^3P_2$	8.753	3.86[04]	$3d4p\ ^1F_3$	8.582	1.83[06]
$3d4p\ ^1P_1$	8.329	1.05[12]	$3d4p\ ^1D_2$	8.598	6.27[06]	$3d4p\ ^3D_3$	8.328	2.99[06]
$3d4f\ ^3P_1$	7.374	1.55[13]	$3d4p\ ^3D_2$	8.315	5.31[03]	$3d4f\ ^3D_3$	7.164	2.76[07]
$3d4f\ ^3D_1$	7.195	3.20[11]	$3d4f\ ^3P_2$	7.386	1.52[07]	$3d4f\ ^3G_3$	7.140	5.70[06]
$3d4f\ ^1P_1$	7.100	6.21[13]	$3d4f\ ^3D_2$	7.177	1.35[08]	$3d4f\ ^3F_3$	6.964	1.76[07]
$3p4s\ ^1P_1$	6.897	2.60[14]	$3d4f\ ^1D_2$	7.161	3.38[08]	$3d4f\ ^1F_3$	6.958	7.23[05]
$3p4s\ ^3P_1$	6.536	3.55[12]	$3d4f\ ^3F_2$	6.985	1.03[05]	$3p4d\ ^3F_3$	6.301	4.14[07]
$3p4d\ ^3P_1$	6.304	2.04[12]	$3p4s\ ^3P_2$	6.974	9.34[07]	$3p4d\ ^1F_3$	6.241	2.20[07]
$3p4d\ ^1P_1$	6.248	6.32[13]	$3p4d\ ^3F_2$	6.293	9.67[05]	$3p4d\ ^3D_3$	5.632	4.87[07]
$3p4d\ ^3D_1$	5.684	4.15[13]	$3p4d\ ^3P_2$	6.250	1.04[08]	$3s4f\ ^3F_3$	4.859	5.55[08]
$3s4p\ ^3P_1$	5.631	4.99[12]	$3p4d\ ^3D_2$	5.671	1.41[06]	$3s4f\ ^1F_3$	4.848	5.73[07]
$3s4p\ ^1P_1$	5.468	3.23[13]	$3p4d\ ^1D_2$	5.638	2.09[07]			
			$3s4p\ ^3P_2$	5.470	8.03[06]			
			$3s4f\ ^3F_2$	4.862	1.92[04]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=69$ , even-parity states								
$3d4s\ ^3D_1$	9.311	5.89[03]	$3d4s\ ^3D_2$	9.641	2.86[09]	$3d4s\ ^3D_3$	9.653	2.99[03]
$3d4d\ ^3S_1$	7.904	2.83[07]	$3d4s\ ^1D_2$	9.303	2.21[09]	$3d4d\ ^3G_3$	7.867	7.68[02]
$3d4d\ ^1P_1$	7.820	1.05[07]	$3d4d\ ^3P_2$	7.877	1.97[09]	$3d4d\ ^3D_3$	7.797	3.11[04]
$3d4d\ ^3D_1$	7.657	6.72[06]	$3d4d\ ^3D_2$	7.791	1.26[10]	$3d4d\ ^3F_3$	7.655	7.77[02]
$3d4d\ ^3P_1$	7.593	9.43[06]	$3d4d\ ^3F_2$	7.632	8.64[09]	$3d4d\ ^1F_3$	7.566	1.64[02]
$3p4p\ ^3D_1$	7.030	1.76[08]	$3d4d\ ^1D_2$	7.574	3.50[09]	$3p4p\ ^3D_3$	6.758	4.95[04]
$3p4p\ ^3S_1$	6.758	6.38[06]	$3p4p\ ^3D_2$	7.025	1.56[10]	$3p4f\ ^3D_3$	5.834	1.07[05]
$3p4p\ ^1P_1$	6.261	1.46[06]	$3p4p\ ^1D_2$	6.741	1.54[10]	$3p4f\ ^3G_3$	5.829	5.15[05]
$3p4p\ ^3P_1$	6.045	1.70[08]	$3p4p\ ^3P_2$	6.038	2.12[10]	$3p4f\ ^3F_3$	5.292	5.28[04]
$3p4f\ ^3D_1$	5.875	1.60[07]	$3p4f\ ^3D_2$	5.846	4.32[09]	$3s4d\ ^3D_3$	5.137	3.21[05]
$3s4s\ ^3S_1$	5.859	5.65[05]	$3p4f\ ^1D_2$	5.812	3.01[11]			
$3s4d\ ^3D_1$	5.170	1.14[04]	$3p4f\ ^3F_2$	5.289	1.94[11]			
			$3s4d\ ^3D_2$	5.168	3.19[10]			
			$3s4d\ ^1D_2$	5.135	8.34[10]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=70$ , odd-parity states								
$3d4p\ ^3P_1$	8.383	4.57[12]	$3d4p\ ^3F_2$	8.700	2.18[06]	$3d4p\ ^3F_3$	8.692	2.09[06]
$3d4p\ ^3D_1$	8.239	9.54[12]	$3d4p\ ^3P_2$	8.400	5.02[04]	$3d4p\ ^1F_3$	8.229	2.18[06]
$3d4p\ ^1P_1$	7.978	1.12[12]	$3d4p\ ^1D_2$	8.244	7.42[06]	$3d4p\ ^3D_3$	7.978	3.58[06]
$3d4f\ ^3P_1$	7.102	1.67[13]	$3d4p\ ^3D_2$	7.965	5.29[03]	$3d4f\ ^3D_3$	6.888	3.11[07]
$3d4f\ ^3D_1$	6.916	3.07[11]	$3d4f\ ^3P_2$	7.112	1.77[07]	$3d4f\ ^3G_3$	6.864	7.72[06]
$3d4f\ ^1P_1$	6.825	7.12[13]	$3d4f\ ^3D_2$	6.899	1.43[08]	$3d4f\ ^3F_3$	6.689	2.07[07]
$3p4s\ ^1P_1$	6.626	2.81[14]	$3d4f\ ^1D_2$	6.884	4.14[08]	$3d4f\ ^1F_3$	6.683	1.08[06]
$3p4s\ ^3P_1$	6.270	3.78[12]	$3d4f\ ^3F_2$	6.709	6.36[03]	$3p4d\ ^3F_3$	6.068	4.81[07]
$3p4d\ ^3P_1$	6.071	2.55[12]	$3p4s\ ^3P_2$	6.699	1.11[08]	$3p4d\ ^1F_3$	6.009	2.60[07]
$3p4d\ ^1P_1$	6.015	6.85[13]	$3p4d\ ^3F_2$	6.060	9.86[05]	$3p4d\ ^3D_3$	5.403	5.74[07]
$3p4d\ ^3D_1$	5.461	4.48[13]	$3p4d\ ^3P_2$	6.017	1.23[08]	$3s4f\ ^3F_3$	4.674	6.40[08]
$3s4p\ ^3P_1$	5.412	3.89[12]	$3p4d\ ^3D_2$	5.448	1.73[06]	$3s4f\ ^1F_3$	4.662	7.56[07]
$3s4p\ ^1P_1$	5.251	2.96[13]	$3p4d\ ^1D_2$	5.409	2.52[07]			
			$3s4p\ ^3P_2$	5.253	1.11[07]			
			$3s4f\ ^3F_2$	4.676	2.41[04]			

level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=70$ , even-parity states								
$3d4s\ ^3D_1$	8.927	7.28[03]	$3d4s\ ^3D_2$	9.254	3.25[09]	$3d4s\ ^3D_3$	9.265	3.70[03]
$3d4d\ ^3S_1$	7.590	3.41[07]	$3d4s\ ^1D_2$	8.920	2.51[09]	$3d4d\ ^3G_3$	7.555	9.14[02]
$3d4d\ ^1P_1$	7.507	1.32[07]	$3d4d\ ^3P_2$	7.564	2.31[09]	$3d4d\ ^3D_3$	7.485	3.85[04]
$3d4d\ ^3D_1$	7.347	7.85[06]	$3d4d\ ^3D_2$	7.479	1.43[10]	$3d4d\ ^3F_3$	7.345	9.41[02]
$3d4d\ ^3P_1$	7.283	1.12[07]	$3d4d\ ^3F_2$	7.323	9.73[09]	$3d4d\ ^1F_3$	7.257	1.86[02]
$3p4p\ ^3D_1$	6.774	2.11[08]	$3d4d\ ^1D_2$	7.264	3.95[09]	$3p4p\ ^3D_3$	6.501	6.10[04]
$3p4p\ ^3S_1$	6.501	8.04[06]	$3p4p\ ^3D_2$	6.769	1.74[10]	$3p4f\ ^3D_3$	5.622	1.06[05]
$3p4p\ ^1P_1$	6.010	1.76[06]	$3p4p\ ^1D_2$	6.485	1.73[10]	$3p4f\ ^3G_3$	5.617	6.65[05]
$3p4p\ ^3P_1$	5.796	2.03[08]	$3p4p\ ^3P_2$	5.789	2.46[10]	$3p4f\ ^3F_3$	5.083	4.15[04]
$3p4f\ ^3D_1$	5.645	1.01[06]	$3p4f\ ^3D_2$	5.633	4.06[09]	$3s4d\ ^3D_3$	4.936	3.94[05]
$3s4s\ ^3S_1$	5.646	2.05[07]	$3p4f\ ^1D_2$	5.600	3.38[11]			
$3s4d\ ^3D_1$	4.970	1.44[04]	$3p4f\ ^3F_2$	5.081	2.32[11]			
			$3s4d\ ^3D_2$	4.967	3.33[10]			
			$3s4d\ ^1D_2$	4.935	9.58[10]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=71$ , odd-parity states								
$3d4p\ ^3P_1$	8.053	5.05[12]	$3d4p\ ^3F_2$	8.365	2.55[06]	$3d4p\ ^3F_3$	8.358	2.44[06]
$3d4p\ ^3D_1$	7.908	1.03[13]	$3d4p\ ^3P_2$	8.068	6.44[04]	$3d4p\ ^1F_3$	7.898	2.58[06]
$3d4p\ ^1P_1$	7.650	1.19[12]	$3d4p\ ^1D_2$	7.913	8.74[06]	$3d4p\ ^3D_3$	7.649	4.27[06]
$3d4f\ ^3P_1$	6.844	1.79[13]	$3d4p\ ^3D_2$	7.638	5.23[03]	$3d4f\ ^3D_3$	6.627	3.50[07]
$3d4f\ ^3D_1$	6.654	2.96[11]	$3d4f\ ^3P_2$	6.855	2.05[07]	$3d4f\ ^3G_3$	6.603	1.03[07]
$3d4f\ ^1P_1$	6.565	8.11[13]	$3d4f\ ^3D_2$	6.638	1.50[08]	$3d4f\ ^3F_3$	6.431	2.42[07]
$3p4s\ ^1P_1$	6.372	3.02[14]	$3d4f\ ^1D_2$	6.623	5.04[08]	$3d4f\ ^1F_3$	6.424	1.55[06]
$3p4s\ ^3P_1$	6.019	4.23[12]	$3d4f\ ^3F_2$	6.449	3.35[05]	$3p4d\ ^3F_3$	5.848	5.57[07]
$3p4d\ ^3P_1$	5.850	2.98[12]	$3p4s\ ^3P_2$	6.439	1.32[08]	$3p4d\ ^1F_3$	5.789	3.07[07]
$3p4d\ ^1P_1$	5.795	7.42[13]	$3p4d\ ^3F_2$	5.840	1.03[06]	$3p4d\ ^3D_3$	5.187	6.73[07]
$3p4d\ ^3D_1$	5.247	4.55[13]	$3p4d\ ^3P_2$	5.797	1.45[08]	$3s4f\ ^3F_3$	4.498	7.43[08]
$3s4p\ ^3P_1$	5.206	3.61[12]	$3p4d\ ^3D_2$	5.230	2.11[06]	$3s4f\ ^1F_3$	4.486	9.73[07]
$3s4p\ ^1P_1$	5.046	2.87[13]	$3p4d\ ^1D_2$	5.193	3.00[07]			
			$3s4p\ ^3P_2$	5.048	1.40[07]			
			$3s4f\ ^3F_2$	4.500	3.12[04]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=71$ , even-parity states								
$3d4s\ ^3D_1$	8.567	8.96[03]	$3d4s\ ^3D_2$	8.890	3.69[09]	$3d4s\ ^3D_3$	8.901	4.55[03]
$3d4d\ ^3S_1$	7.295	4.08[07]	$3d4s\ ^1D_2$	8.560	2.84[09]	$3d4d\ ^3G_3$	7.262	1.08[03]
$3d4d\ ^1P_1$	7.213	1.65[07]	$3d4d\ ^3P_2$	7.271	2.69[09]	$3d4d\ ^3D_3$	7.192	4.75[04]
$3d4d\ ^3D_1$	7.055	9.15[06]	$3d4d\ ^3D_2$	7.186	1.62[10]	$3d4d\ ^3F_3$	7.053	1.13[03]
$3d4d\ ^3P_1$	6.991	1.33[07]	$3d4d\ ^3F_2$	7.033	1.10[10]	$3d4d\ ^1F_3$	6.967	2.27[02]
$3p4p\ ^3D_1$	6.531	2.52[08]	$3d4d\ ^1D_2$	6.973	4.45[09]	$3p4p\ ^3D_3$	6.259	7.46[04]
$3p4p\ ^3S_1$	6.259	1.01[07]	$3p4p\ ^3D_2$	6.527	1.95[10]	$3p4f\ ^3D_3$	5.421	1.02[05]
$3p4p\ ^1P_1$	5.772	2.13[06]	$3p4p\ ^1D_2$	6.244	1.95[10]	$3p4f\ ^3G_3$	5.415	8.39[05]
$3p4p\ ^3P_1$	5.560	2.41[08]	$3p4p\ ^3P_2$	5.553	2.90[10]	$3p4f\ ^3F_3$	4.885	1.45[05]
$3p4f\ ^3D_1$	5.443	8.99[05]	$3p4f\ ^3D_2$	5.432	3.27[09]	$3s4d\ ^3D_3$	4.748	4.82[05]
$3s4s\ ^3S_1$	5.429	2.72[07]	$3p4f\ ^1D_2$	5.400	3.85[11]			
$3s4d\ ^3D_1$	4.781	1.80[04]	$3p4f\ ^3F_2$	4.883	2.74[11]			
			$3s4d\ ^3D_2$	4.779	3.42[10]			
			$3s4d\ ^1D_2$	4.746	1.09[11]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=72$ , odd-parity states								
$3d4p\ ^3P_1$	7.742	5.55[12]	$3d4p\ ^3F_2$	8.051	2.98[06]	$3d4p\ ^3F_3$	8.044	2.84[06]
$3d4p\ ^3D_1$	7.596	1.10[13]	$3d4p\ ^3P_2$	7.757	8.17[04]	$3d4p\ ^1F_3$	7.588	3.04[06]
$3d4p\ ^1P_1$	7.342	1.26[12]	$3d4p\ ^1D_2$	7.601	1.03[07]	$3d4p\ ^3D_3$	7.341	5.08[06]
$3d4f\ ^3P_1$	6.601	1.92[13]	$3d4p\ ^3D_2$	7.330	5.08[03]	$3d4f\ ^3D_3$	6.381	3.91[07]
$3d4f\ ^3D_1$	6.407	2.80[11]	$3d4f\ ^3P_2$	6.611	2.37[07]	$3d4f\ ^3G_3$	6.357	1.35[07]
$3d4f\ ^1P_1$	6.320	9.22[13]	$3d4f\ ^3D_2$	6.391	1.56[08]	$3d4f\ ^3F_3$	6.187	2.82[07]
$3p4s\ ^1P_1$	6.131	3.24[14]	$3d4f\ ^1D_2$	6.376	6.09[08]	$3d4f\ ^1F_3$	6.179	2.18[06]
$3p4s\ ^3P_1$	5.781	4.67[12]	$3d4f\ ^3F_2$	6.204	1.38[06]	$3p4d\ ^3F_3$	5.639	6.43[07]
$3p4d\ ^3P_1$	5.641	3.61[12]	$3p4s\ ^3P_2$	6.194	1.55[08]	$3p4d\ ^1F_3$	5.580	3.60[07]
$3p4d\ ^1P_1$	5.586	8.03[13]	$3p4d\ ^3F_2$	5.631	1.06[06]	$3p4d\ ^3D_3$	4.983	7.85[07]
$3p4d\ ^3D_1$	5.047	4.87[13]	$3p4d\ ^3P_2$	5.588	1.70[08]	$3s4f\ ^3F_3$	4.331	8.50[08]
$3s4p\ ^3P_1$	5.006	5.58[12]	$3p4d\ ^3D_2$	5.026	2.55[06]	$3s4f\ ^1F_3$	4.319	1.26[08]
$3s4p\ ^1P_1$	4.852	2.93[13]	$3p4d\ ^1D_2$	4.989	3.56[07]			
			$3s4p\ ^3P_2$	4.854	1.68[07]			
			$3s4f\ ^3F_2$	4.333	3.80[04]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=72$ , even-parity states								
$3d4s\ ^3D_1$	8.228	1.10[04]	$3d4s\ ^3D_2$	8.549	4.19[09]	$3d4s\ ^3D_3$	8.559	5.58[03]
$3d4d\ ^3S_1$	7.017	4.88[07]	$3d4s\ ^1D_2$	8.222	3.21[09]	$3d4d\ ^3G_3$	6.986	1.26[03]
$3d4d\ ^1P_1$	6.936	2.06[07]	$3d4d\ ^3P_2$	6.994	3.12[09]	$3d4d\ ^3D_3$	6.916	5.82[04]
$3d4d\ ^3D_1$	6.780	1.06[07]	$3d4d\ ^3D_2$	6.911	1.83[10]	$3d4d\ ^3F_3$	6.779	1.36[03]
$3d4d\ ^3P_1$	6.716	1.57[07]	$3d4d\ ^3F_2$	6.759	1.24[10]	$3d4d\ ^1F_3$	6.693	2.48[02]
$3p4p\ ^3D_1$	6.302	3.01[08]	$3d4d\ ^1D_2$	6.700	4.99[09]	$3p4p\ ^3D_3$	6.030	9.06[04]
$3p4p\ ^3S_1$	6.030	1.25[07]	$3p4p\ ^3D_2$	6.299	2.19[10]	$3p4f\ ^3D_3$	5.231	9.69[04]
$3p4p\ ^1P_1$	5.548	2.56[06]	$3p4p\ ^1D_2$	6.016	2.19[10]	$3p4f\ ^3G_3$	5.225	1.04[06]
$3p4p\ ^3P_1$	5.338	2.86[08]	$3p4p\ ^3P_2$	5.331	3.43[10]	$3p4f\ ^3F_3$	4.697	2.53[05]
$3p4f\ ^3D_1$	5.252	8.95[05]	$3p4f\ ^3D_2$	5.241	2.61[09]	$3s4d\ ^3D_3$	4.568	5.88[05]
$3s4s\ ^3S_1$	5.223	3.61[07]	$3p4f\ ^1D_2$	5.210	4.26[11]			
$3s4d\ ^3D_1$	4.601	2.20[04]	$3p4f\ ^3F_2$	4.696	3.27[11]			
			$3s4d\ ^3D_2$	4.599	3.56[10]			
			$3s4d\ ^1D_2$	4.566	1.23[11]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=73$ , odd-parity states								
$3d4p\ ^3P_1$	7.450	6.09[12]	$3d4p\ ^3F_2$	7.755	3.47[06]	$3d4p\ ^3F_3$	7.749	3.29[06]
$3d4p\ ^3D_1$	7.303	1.18[13]	$3d4p\ ^3P_2$	7.464	1.03[05]	$3d4p\ ^1F_3$	7.295	3.57[06]
$3d4p\ ^1P_1$	7.052	1.34[12]	$3d4p\ ^1D_2$	7.308	1.20[07]	$3d4p\ ^3D_3$	7.051	6.01[06]
$3d4f\ ^3P_1$	6.372	2.06[13]	$3d4p\ ^3D_2$	7.041	4.85[03]	$3d4f\ ^3D_3$	6.149	4.35[07]
$3d4f\ ^3D_1$	6.173	2.61[11]	$3d4f\ ^3P_2$	6.381	2.73[07]	$3d4f\ ^3G_3$	6.125	1.73[07]
$3d4f\ ^1P_1$	6.089	1.04[14]	$3d4f\ ^3D_2$	6.158	1.61[08]	$3d4f\ ^3F_3$	5.956	3.27[07]
$3p4s\ ^1P_1$	5.904	3.47[14]	$3d4f\ ^1D_2$	6.144	7.30[08]	$3d4f\ ^1F_3$	5.948	2.98[06]
$3p4s\ ^3P_1$	5.557	5.16[12]	$3d4f\ ^3F_2$	5.972	3.50[06]	$3p4d\ ^3F_3$	5.441	7.40[07]
$3p4d\ ^3P_1$	5.443	4.34[12]	$3p4s\ ^3P_2$	5.963	1.81[08]	$3p4d\ ^1F_3$	5.383	4.22[07]
$3p4d\ ^1P_1$	5.389	8.68[13]	$3p4d\ ^3F_2$	5.434	1.09[06]	$3p4d\ ^3D_3$	4.789	9.12[07]
$3p4d\ ^3D_1$	4.858	4.87[13]	$3p4d\ ^3P_2$	5.390	1.99[08]	$3s4f\ ^3F_3$	4.172	9.75[08]
$3s4p\ ^3P_1$	4.816	6.74[12]	$3p4d\ ^3D_2$	4.832	3.04[06]	$3s4f\ ^1F_3$	4.161	1.61[08]
$3s4p\ ^1P_1$	4.667	3.07[13]	$3p4d\ ^1D_2$	4.795	4.18[07]			
			$3s4p\ ^3P_2$	4.669	1.97[07]			
			$3s4f\ ^3F_2$	4.174	4.60[04]			



level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=73$ , even-parity states								
$3d4s\ ^3D_1$	7.912	1.34[04]	$3d4s\ ^3D_2$	8.230	4.73[09]	$3d4s\ ^3D_3$	8.239	6.78[03]
$3d4d\ ^3S_1$	6.755	5.82[07]	$3d4s\ ^1D_2$	7.906	3.61[09]	$3d4d\ ^3G_3$	6.726	1.48[03]
$3d4d\ ^1P_1$	6.674	2.55[07]	$3d4d\ ^3P_2$	6.734	3.61[09]	$3d4d\ ^3D_3$	6.655	7.11[04]
$3d4d\ ^3D_1$	6.521	1.23[07]	$3d4d\ ^3D_2$	6.651	2.06[10]	$3d4d\ ^3F_3$	6.520	1.62[03]
$3d4d\ ^3P_1$	6.457	1.84[07]	$3d4d\ ^3F_2$	6.501	1.39[10]	$3d4d\ ^1F_3$	6.436	3.22[02]
$3p4p\ ^3D_1$	6.086	3.58[08]	$3d4d\ ^1D_2$	6.441	5.57[09]	$3p4p\ ^3D_3$	5.813	1.10[05]
$3p4p\ ^3S_1$	5.813	1.54[07]	$3p4p\ ^3D_2$	6.082	2.44[10]	$3p4f\ ^3D_3$	5.050	9.16[04]
$3p4p\ ^1P_1$	5.336	3.06[06]	$3p4p\ ^1D_2$	5.799	2.45[10]	$3p4f\ ^3G_3$	5.044	1.28[06]
$3p4p\ ^3P_1$	5.127	3.37[08]	$3p4p\ ^3P_2$	5.120	4.13[10]	$3p4f\ ^3F_3$	4.519	3.67[05]
$3p4f\ ^3D_1$	5.070	7.49[05]	$3p4f\ ^3D_2$	5.060	1.84[09]	$3s4d\ ^3D_3$	4.397	7.15[05]
$3s4s\ ^3S_1$	5.028	4.85[07]	$3p4f\ ^1D_2$	5.030	4.72[11]			
$3s4d\ ^3D_1$	4.430	2.65[04]	$3p4f\ ^3F_2$	4.518	3.86[11]			
			$3s4d\ ^3D_2$	4.427	4.00[10]			
			$3s4d\ ^1D_2$	4.395	1.38[11]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=74$ , odd-parity states								
$3d4p\ ^3P_1$	7.174	6.67[12]	$3d4p\ ^3F_2$	7.477	4.04[06]	$3d4p\ ^3F_3$	7.472	3.80[06]
$3d4p\ ^3D_1$	7.027	1.27[13]	$3d4p\ ^3P_2$	7.188	1.28[05]	$3d4p\ ^1F_3$	7.019	4.18[06]
$3d4p\ ^1P_1$	6.778	1.42[12]	$3d4p\ ^1D_2$	7.032	1.40[07]	$3d4p\ ^3D_3$	6.777	7.10[06]
$3d4f\ ^3P_1$	6.154	2.21[13]	$3d4p\ ^3D_2$	6.768	4.49[03]	$3d4f\ ^3D_3$	5.929	4.82[07]
$3d4f\ ^3D_1$	5.953	2.41[11]	$3d4f\ ^3P_2$	6.164	3.15[07]	$3d4f\ ^3G_3$	5.906	2.20[07]
$3d4f\ ^1P_1$	5.870	1.18[14]	$3d4f\ ^3D_2$	5.938	1.66[08]	$3d4f\ ^3F_3$	5.738	3.79[07]
$3p4s\ ^1P_1$	5.689	3.72[14]	$3d4f\ ^1D_2$	5.923	8.70[08]	$3d4f\ ^1F_3$	5.730	3.99[06]
$3p4s\ ^3P_1$	5.345	5.68[12]	$3d4f\ ^3F_2$	5.753	7.03[06]	$3p4d\ ^3F_3$	5.254	8.50[07]
$3p4d\ ^3P_1$	5.255	5.22[12]	$3p4s\ ^3P_2$	5.744	2.09[08]	$3p4d\ ^1F_3$	5.196	4.93[07]
$3p4d\ ^1P_1$	5.201	9.35[13]	$3p4d\ ^3F_2$	5.247	1.12[06]	$3p4d\ ^3D_3$	4.605	1.06[08]
$3p4d\ ^3D_1$	4.679	4.90[13]	$3p4d\ ^3P_2$	5.203	2.32[08]	$3s4f\ ^3F_3$	4.021	1.12[09]
$3s4p\ ^3P_1$	4.635	1.20[13]	$3p4d\ ^3D_2$	4.648	3.55[06]	$3s4f\ ^1F_3$	4.010	2.04[08]
$3s4p\ ^1P_1$	4.492	3.28[13]	$3p4d\ ^1D_2$	4.612	4.90[07]			
			$3s4p\ ^3P_2$	4.494	2.25[07]			
			$3s4f\ ^3F_2$	4.023	5.05[04]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=74$ , even-parity states								
$3d4s\ ^3D_1$	7.614	1.63[04]	$3d4s\ ^3D_2$	7.929	5.32[09]	$3d4s\ ^3D_3$	7.938	8.22[03]
$3d4d\ ^3S_1$	6.508	6.92[07]	$3d4s\ ^1D_2$	7.608	4.04[09]	$3d4d\ ^3G_3$	6.480	1.73[03]
$3d4d\ ^1P_1$	6.428	3.13[07]	$3d4d\ ^3P_2$	6.487	4.17[09]	$3d4d\ ^3D_3$	6.410	8.64[04]
$3d4d\ ^3D_1$	6.276	1.42[07]	$3d4d\ ^3D_2$	6.405	2.31[10]	$3d4d\ ^3F_3$	6.275	1.93[03]
$3d4d\ ^3P_1$	6.212	2.15[07]	$3d4d\ ^3F_2$	6.258	1.56[10]	$3d4d\ ^1F_3$	6.192	4.13[02]
$3p4p\ ^3D_1$	5.881	4.25[08]	$3d4d\ ^1D_2$	6.198	6.19[09]	$3p4p\ ^3D_3$	5.607	1.32[05]
$3p4p\ ^3S_1$	5.607	1.90[07]	$3p4p\ ^3D_2$	5.878	2.72[10]	$3p4f\ ^3D_3$	4.879	8.64[04]
$3p4p\ ^1P_1$	5.134	3.66[06]	$3p4p\ ^1D_2$	5.595	2.74[10]	$3p4f\ ^3G_3$	4.872	1.56[06]
$3p4p\ ^3P_1$	4.928	3.95[08]	$3p4p\ ^3P_2$	4.921	4.99[10]	$3p4f\ ^3F_3$	4.350	4.92[05]
$3p4f\ ^3D_1$	4.898	2.01[05]	$3p4f\ ^3D_2$	4.888	6.88[08]	$3s4d\ ^3D_3$	4.234	8.66[05]
$3s4s\ ^3S_1$	4.842	6.58[07]	$3p4f\ ^1D_2$	4.858	5.19[11]			
$3s4d\ ^3D_1$	4.267	3.14[04]	$3p4f\ ^3F_2$	4.350	4.66[11]			
			$3s4d\ ^3D_2$	4.265	4.43[10]			
			$3s4d\ ^1D_2$	4.233	1.56[11]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=75$ , odd-parity states								
$3d4p\ ^3P_1$	6.915	7.28[12]	$3d4p\ ^3F_2$	7.215	4.68[06]	$3d4p\ ^3F_3$	7.210	4.37[06]
$3d4p\ ^3D_1$	6.767	1.36[13]	$3d4p\ ^3P_2$	6.928	1.58[05]	$3d4p\ ^1F_3$	6.760	4.88[06]
$3d4p\ ^1P_1$	6.521	1.50[12]	$3d4p\ ^1D_2$	6.771	1.63[07]	$3d4p\ ^3D_3$	6.519	8.34[06]
$3d4f\ ^3P_1$	5.948	2.37[13]	$3d4p\ ^3D_2$	6.511	4.03[03]	$3d4f\ ^3D_3$	5.721	5.33[07]
$3d4f\ ^3D_1$	5.743	2.18[11]	$3d4f\ ^3P_2$	5.957	3.63[07]	$3d4f\ ^3G_3$	5.698	2.76[07]
$3d4f\ ^1P_1$	5.663	1.32[14]	$3d4f\ ^3D_2$	5.729	1.70[08]	$3d4f\ ^3F_3$	5.532	4.36[07]
$3p4s\ ^1P_1$	5.486	3.97[14]	$3d4f\ ^1D_2$	5.715	1.03[09]	$3d4f\ ^1F_3$	5.523	5.25[06]
$3p4s\ ^3P_1$	5.144	6.21[12]	$3d4f\ ^3F_2$	5.546	1.23[07]	$3p4d\ ^3F_3$	5.075	9.73[07]
$3p4d\ ^3P_1$	5.076	6.37[12]	$3p4s\ ^3P_2$	5.537	2.41[08]	$3p4d\ ^1F_3$	5.018	5.74[07]
$3p4d\ ^1P_1$	5.023	1.01[14]	$3p4d\ ^3F_2$	5.069	1.15[06]	$3p4d\ ^3D_3$	4.431	1.23[08]
$3p4d\ ^3D_1$	4.510	4.90[13]	$3p4d\ ^3P_2$	5.025	2.69[08]	$3s4f\ ^3F_3$	3.877	1.27[09]
$3s4p\ ^3P_1$	4.463	1.80[13]	$3p4d\ ^3D_2$	4.473	4.13[06]	$3s4f\ ^1F_3$	3.866	2.56[08]
$3s4p\ ^1P_1$	4.325	3.58[13]	$3p4d\ ^1D_2$	4.437	5.70[07]			
			$3s4p\ ^3P_2$	4.327	2.51[07]			
			$3s4f\ ^3F_2$	3.879	7.29[04]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=75$ , even-parity states								
$3d4s\ ^3D_1$	7.333	1.98[04]	$3d4s\ ^3D_2$	7.646	5.97[09]	$3d4s\ ^3D_3$	7.655	9.92[03]
$3d4d\ ^3S_1$	6.274	8.20[07]	$3d4s\ ^1D_2$	7.328	4.57[09]	$3d4d\ ^3G_3$	6.248	2.02[03]
$3d4d\ ^1P_1$	6.195	3.84[07]	$3d4d\ ^3P_2$	6.255	4.78[09]	$3d4d\ ^3D_3$	6.177	1.05[05]
$3d4d\ ^3D_1$	6.045	1.64[07]	$3d4d\ ^3D_2$	6.173	2.59[10]	$3d4d\ ^3F_3$	6.044	2.29[03]
$3d4d\ ^3P_1$	5.981	2.49[07]	$3d4d\ ^3F_2$	6.027	1.76[10]	$3d4d\ ^1F_3$	5.962	5.24[02]
$3p4p\ ^3D_1$	5.686	5.02[08]	$3d4d\ ^1D_2$	5.967	6.97[09]	$3p4p\ ^3D_3$	5.413	1.59[05]
$3p4p\ ^3S_1$	5.412	2.32[07]	$3p4p\ ^3D_2$	5.683	3.02[10]	$3p4f\ ^3D_3$	4.716	8.16[04]
$3p4p\ ^1P_1$	4.944	4.36[06]	$3p4p\ ^1D_2$	5.400	3.07[10]	$3p4f\ ^3G_3$	4.709	1.89[06]
$3p4p\ ^3P_1$	4.737	4.10[08]	$3p4p\ ^3P_2$	4.731	9.55[10]	$3p4f\ ^3F_3$	4.189	6.28[05]
$3p4f\ ^3D_1$	4.736	4.83[07]	$3p4f\ ^3D_2$	4.724	1.10[09]	$3s4d\ ^3D_3$	4.079	1.05[06]
$3s4s\ ^3S_1$	4.666	9.07[07]	$3p4f\ ^1D_2$	4.695	5.43[11]			
$3s4d\ ^3D_1$	4.112	3.66[04]	$3p4f\ ^3F_2$	4.189	5.57[11]			
			$3s4d\ ^3D_2$	4.110	4.90[10]			
			$3s4d\ ^1D_2$	4.078	1.74[11]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=76$ , odd-parity states								
$3d4p\ ^3P_1$	6.670	7.94[12]	$3d4p\ ^3F_2$	6.968	5.41[06]	$3d4p\ ^3F_3$	6.963	5.01[06]
$3d4p\ ^3D_1$	6.521	1.46[13]	$3d4p\ ^3P_2$	6.682	1.93[05]	$3d4p\ ^1F_3$	6.514	5.67[06]
$3d4p\ ^1P_1$	6.277	1.58[12]	$3d4p\ ^1D_2$	6.525	1.90[07]	$3d4p\ ^3D_3$	6.276	9.78[06]
$3d4f\ ^3P_1$	5.753	2.54[13]	$3d4p\ ^3D_2$	6.268	3.44[03]	$3d4f\ ^3D_3$	5.524	5.88[07]
$3d4f\ ^3D_1$	5.545	1.94[11]	$3d4f\ ^3P_2$	5.762	4.17[07]	$3d4f\ ^3G_3$	5.501	3.41[07]
$3d4f\ ^1P_1$	5.467	1.48[14]	$3d4f\ ^3D_2$	5.532	1.73[08]	$3d4f\ ^3F_3$	5.337	5.01[07]
$3p4s\ ^1P_1$	5.293	4.23[14]	$3d4f\ ^1D_2$	5.517	1.21[09]	$3d4f\ ^1F_3$	5.328	6.80[06]
$3p4s\ ^3P_1$	4.953	6.58[12]	$3d4f\ ^3F_2$	5.350	1.97[07]	$3p4d\ ^3F_3$	4.906	1.11[08]
$3p4d\ ^3P_1$	4.907	8.04[12]	$3p4s\ ^3P_2$	5.341	2.76[08]	$3p4d\ ^1F_3$	4.849	6.66[07]
$3p4d\ ^1P_1$	4.854	1.08[14]	$3p4d\ ^3F_2$	4.900	1.18[06]	$3p4d\ ^3D_3$	4.266	1.44[08]
$3p4d\ ^3D_1$	4.349	4.90[13]	$3p4d\ ^3P_2$	4.855	3.12[08]	$3s4f\ ^3F_3$	3.740	1.45[09]
$3s4p\ ^3P_1$	4.299	2.39[13]	$3p4d\ ^3D_2$	4.308	4.83[06]	$3s4f\ ^1F_3$	3.730	3.20[08]
$3s4p\ ^1P_1$	4.167	4.02[13]	$3p4d\ ^1D_2$	4.271	6.60[07]			
			$3s4p\ ^3P_2$	4.169	2.70[07]			
			$3s4f\ ^3F_2$	3.742	1.10[05]			

level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=76$ , even-parity states								
$3d4s\ ^3D_1$	7.068	2.39[04]	$3d4s\ ^3D_2$	7.380	6.69[09]	$3d4s\ ^3D_3$	7.388	1.19[04]
$3d4d\ ^3S_1$	6.053	9.70[07]	$3d4s\ ^1D_2$	7.063	5.09[09]	$3d4d\ ^3G_3$	6.028	2.35[03]
$3d4d\ ^1P_1$	5.974	4.67[07]	$3d4d\ ^3P_2$	6.035	5.46[09]	$3d4d\ ^3D_3$	5.958	1.26[05]
$3d4d\ ^3D_1$	5.827	1.88[07]	$3d4d\ ^3D_2$	5.954	2.90[10]	$3d4d\ ^3F_3$	5.826	2.71[03]
$3d4d\ ^3P_1$	5.763	2.88[07]	$3d4d\ ^3F_2$	5.810	1.97[10]	$3d4d\ ^1F_3$	5.745	6.60[02]
$3p4p\ ^3D_1$	5.502	5.93[08]	$3d4d\ ^1D_2$	5.750	7.68[09]	$3p4p\ ^3D_3$	5.228	1.90[05]
$3p4p\ ^3S_1$	5.227	2.82[07]	$3p4p\ ^3D_2$	5.499	3.35[10]	$3p4f\ ^3D_3$	4.561	7.65[04]
$3p4p\ ^1P_1$	4.762	5.17[06]	$3p4p\ ^1D_2$	5.216	3.41[10]	$3p4f\ ^3G_3$	4.554	2.27[06]
$3p4p\ ^3P_1$	4.578	1.10[07]	$3p4p\ ^3P_2$	4.569	1.34[10]	$3p4f\ ^3F_3$	4.036	7.77[05]
$3p4f\ ^3D_1$	4.560	5.12[08]	$3p4f\ ^3D_2$	4.552	2.64[11]	$3s4d\ ^3D_3$	3.932	1.26[06]
$3s4s\ ^3S_1$	4.498	1.28[08]	$3p4f\ ^1D_2$	4.540	4.18[11]			
$3s4d\ ^3D_1$	3.965	4.18[04]	$3p4f\ ^3F_2$	4.037	6.49[11]			
			$3s4d\ ^3D_2$	3.963	5.39[10]			
			$3s4d\ ^1D_2$	3.931	1.95[11]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=77$ , odd-parity states								
$3d4p\ ^3P_1$	6.439	8.64[12]	$3d4p\ ^3F_2$	6.734	6.24[06]	$3d4p\ ^3F_3$	6.729	5.73[06]
$3d4p\ ^3D_1$	6.289	1.56[13]	$3d4p\ ^3P_2$	6.451	2.35[05]	$3d4p\ ^1F_3$	6.282	6.58[06]
$3d4p\ ^1P_1$	6.047	1.67[12]	$3d4p\ ^1D_2$	6.292	2.20[07]	$3d4p\ ^3D_3$	6.046	1.14[07]
$3d4f\ ^3P_1$	5.568	2.71[13]	$3d4p\ ^3D_2$	6.038	2.74[03]	$3d4f\ ^3D_3$	5.337	6.46[07]
$3d4f\ ^3D_1$	5.358	1.69[11]	$3d4f\ ^3P_2$	5.576	4.78[07]	$3d4f\ ^3G_3$	5.315	4.18[07]
$3d4f\ ^1P_1$	5.281	1.66[14]	$3d4f\ ^3D_2$	5.345	1.76[08]	$3d4f\ ^3F_3$	5.151	5.74[07]
$3p4s\ ^1P_1$	5.110	4.50[14]	$3d4f\ ^1D_2$	5.330	1.42[09]	$3d4f\ ^1F_3$	5.142	8.68[06]
$3p4s\ ^3P_1$	4.772	6.16[12]	$3d4f\ ^3F_2$	5.164	2.94[07]	$3p4d\ ^3F_3$	4.745	1.27[08]
$3p4d\ ^3P_1$	4.745	1.11[13]	$3p4s\ ^3P_2$	5.154	3.14[08]	$3p4d\ ^1F_3$	4.688	7.71[07]
$3p4d\ ^1P_1$	4.693	1.15[14]	$3p4d\ ^3F_2$	4.739	1.21[06]	$3p4d\ ^3D_3$	4.109	1.70[08]
$3p4d\ ^3D_1$	4.197	4.99[13]	$3p4d\ ^3P_2$	4.694	3.60[08]	$3s4f\ ^3F_3$	3.610	1.65[09]
$3s4p\ ^3P_1$	4.142	2.97[13]	$3p4d\ ^3D_2$	4.150	5.60[06]	$3s4f\ ^1F_3$	3.599	3.97[08]
$3s4p\ ^1P_1$	4.016	4.72[13]	$3p4d\ ^1D_2$	4.114	7.57[07]			
			$3s4p\ ^3P_2$	4.018	2.73[07]			
			$3s4f\ ^3F_2$	3.612	1.97[05]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=77$ , even-parity states								
$3d4s\ ^3D_1$	6.819	2.89[04]	$3d4s\ ^3D_2$	7.128	7.48[09]	$3d4s\ ^3D_3$	7.136	1.42[04]
$3d4d\ ^3S_1$	5.844	1.14[08]	$3d4s\ ^1D_2$	6.814	5.67[09]	$3d4d\ ^3G_3$	5.820	2.71[03]
$3d4d\ ^1P_1$	5.765	5.67[07]	$3d4d\ ^3P_2$	5.826	6.25[09]	$3d4d\ ^3D_3$	5.750	1.51[05]
$3d4d\ ^3D_1$	5.620	2.15[07]	$3d4d\ ^3D_2$	5.746	3.24[10]	$3d4d\ ^3F_3$	5.619	3.19[03]
$3d4d\ ^3P_1$	5.556	3.31[07]	$3d4d\ ^3F_2$	5.604	2.20[10]	$3d4d\ ^1F_3$	5.539	8.32[02]
$3p4p\ ^3D_1$	5.327	6.99[08]	$3d4d\ ^1D_2$	5.543	8.49[09]	$3p4p\ ^3D_3$	5.052	2.27[05]
$3p4p\ ^3S_1$	5.052	3.41[07]	$3p4p\ ^3D_2$	5.324	3.72[10]	$3p4f\ ^3D_3$	4.413	7.05[04]
$3p4p\ ^1P_1$	4.590	6.12[06]	$3p4p\ ^1D_2$	5.041	3.80[10]	$3p4f\ ^3G_3$	4.406	2.52[06]
$3p4p\ ^3P_1$	4.430	7.47[06]	$3p4p\ ^3P_2$	4.421	4.41[09]	$3p4f\ ^3F_3$	3.890	9.40[05]
$3p4f\ ^3D_1$	4.390	5.80[08]	$3p4f\ ^3D_2$	4.395	8.06[11]	$3s4d\ ^3D_3$	3.792	1.52[06]
$3s4s\ ^3S_1$	4.338	1.84[08]	$3p4f\ ^1D_2$	4.378	1.83[09]			
$3s4d\ ^3D_1$	3.824	4.68[04]	$3p4f\ ^3F_2$	3.892	7.32[11]			
			$3s4d\ ^3D_2$	3.822	5.90[10]			
			$3s4d\ ^1D_2$	3.791	2.18[11]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=78$ , odd-parity states								
$3d4p\ ^3P_1$	6.220	9.39[12]	$3d4p\ ^3F_2$	6.513	7.18[06]	$3d4p\ ^3F_3$	6.509	6.53[06]
$3d4p\ ^3D_1$	6.069	1.67[13]	$3d4p\ ^3P_2$	6.231	2.85[05]	$3d4p\ ^1F_3$	6.062	7.61[06]
$3d4p\ ^1P_1$	5.829	1.75[12]	$3d4p\ ^1D_2$	6.072	2.53[07]	$3d4p\ ^3D_3$	5.828	1.33[07]
$3d4f\ ^3P_1$	5.392	2.91[13]	$3d4p\ ^3D_2$	5.821	1.98[03]	$3d4f\ ^3D_3$	5.160	7.09[07]
$3d4f\ ^3D_1$	5.179	1.42[11]	$3d4f\ ^3P_2$	5.400	5.47[07]	$3d4f\ ^3G_3$	5.138	5.07[07]
$3d4f\ ^1P_1$	5.105	1.85[14]	$3d4f\ ^3D_2$	5.167	1.79[08]	$3d4f\ ^3F_3$	4.975	6.56[07]
$3p4s\ ^1P_1$	4.937	4.79[14]	$3d4f\ ^1D_2$	5.152	1.66[09]	$3d4f\ ^1F_3$	4.965	1.10[07]
$3p4s\ ^3P_1$	4.603	2.25[12]	$3d4f\ ^3F_2$	4.987	4.17[07]	$3p4d\ ^3F_3$	4.592	1.44[08]
$3p4d\ ^3P_1$	4.589	1.87[13]	$3p4s\ ^3P_2$	4.977	3.57[08]	$3p4d\ ^1F_3$	4.535	8.91[07]
$3p4d\ ^1P_1$	4.540	1.22[14]	$3p4d\ ^3F_2$	4.586	1.23[06]	$3p4d\ ^3D_3$	3.959	2.00[08]
$3p4d\ ^3D_1$	4.051	5.27[13]	$3p4d\ ^3P_2$	4.541	4.15[08]	$3s4f\ ^3F_3$	3.485	1.88[09]
$3s4p\ ^3P_1$	3.993	3.51[13]	$3p4d\ ^3D_2$	4.000	6.47[06]	$3s4f\ ^1F_3$	3.475	4.90[08]
$3s4p\ ^1P_1$	3.873	4.23[13]	$3p4d\ ^1D_2$	3.964	8.58[07]			
			$3s4p\ ^3P_2$	3.874	2.40[07]			
			$3s4f\ ^3F_2$	3.487	2.31[05]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=78$ , even-parity states								
$3d4s\ ^3D_1$	6.583	3.47[04]	$3d4s\ ^3D_2$	6.890	8.34[09]	$3d4s\ ^3D_3$	6.898	1.70[04]
$3d4d\ ^3S_1$	5.646	1.35[08]	$3d4s\ ^1D_2$	6.578	6.31[09]	$3d4d\ ^3G_3$	5.623	3.15[03]
$3d4d\ ^1P_1$	5.567	6.84[07]	$3d4d\ ^3P_2$	5.629	7.11[09]	$3d4d\ ^3D_3$	5.553	1.81[05]
$3d4d\ ^3D_1$	5.424	2.45[07]	$3d4d\ ^3D_2$	5.549	3.61[10]	$3d4d\ ^3F_3$	5.423	3.76[03]
$3d4d\ ^3P_1$	5.360	3.77[07]	$3d4d\ ^3F_2$	5.408	2.45[10]	$3d4d\ ^1F_3$	5.343	1.03[03]
$3p4p\ ^3D_1$	5.160	8.21[08]	$3d4d\ ^1D_2$	5.348	9.34[09]	$3p4p\ ^3D_3$	4.885	2.70[05]
$3p4p\ ^3S_1$	4.885	4.11[07]	$3p4p\ ^3D_2$	5.158	4.11[10]	$3p4f\ ^3D_3$	4.273	6.50[04]
$3p4p\ ^1P_1$	4.426	7.22[06]	$3p4p\ ^1D_2$	4.874	4.22[10]	$3p4f\ ^3G_3$	4.265	3.19[06]
$3p4p\ ^3P_1$	4.288	7.16[06]	$3p4p\ ^3P_2$	4.280	2.35[09]	$3p4f\ ^3F_3$	3.751	1.10[06]
$3p4f\ ^3D_1$	4.229	6.33[08]	$3p4f\ ^3D_2$	4.254	8.55[11]	$3s4d\ ^3D_3$	3.658	1.82[06]
$3s4s\ ^3S_1$	4.185	2.73[08]	$3p4f\ ^1D_2$	4.217	1.51[10]			
$3s4d\ ^3D_1$	3.690	5.08[04]	$3p4f\ ^3F_2$	3.753	9.28[11]			
			$3s4d\ ^3D_2$	3.688	6.51[10]			
			$3s4d\ ^1D_2$	3.657	2.43[11]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=79$ , odd-parity states								
$3d4p\ ^3P_1$	6.013	1.02[13]	$3d4p\ ^3F_2$	6.304	8.23[06]	$3d4p\ ^3F_3$	6.300	7.42[06]
$3d4p\ ^3D_1$	5.861	1.78[13]	$3d4p\ ^3P_2$	6.024	3.43[05]	$3d4p\ ^1F_3$	5.854	8.77[06]
$3d4p\ ^1P_1$	5.623	1.85[12]	$3d4p\ ^1D_2$	5.864	2.92[07]	$3d4p\ ^3D_3$	5.622	1.54[07]
$3d4f\ ^3P_1$	5.225	3.12[13]	$3d4p\ ^3D_2$	5.615	1.25[03]	$3d4f\ ^3D_3$	4.991	7.77[07]
$3d4f\ ^3D_1$	5.010	1.16[11]	$3d4f\ ^3P_2$	5.233	6.23[07]	$3d4f\ ^3G_3$	4.969	6.10[07]
$3d4f\ ^1P_1$	4.937	2.05[14]	$3d4f\ ^3D_2$	4.998	1.81[08]	$3d4f\ ^3F_3$	4.808	7.48[07]
$3p4s\ ^1P_1$	4.772	5.09[14]	$3d4f\ ^1D_2$	4.983	1.93[09]	$3d4f\ ^1F_3$	4.798	1.37[07]
$3p4s\ ^3P_1$	4.450	3.48[12]	$3d4f\ ^3F_2$	4.819	5.69[07]	$3p4d\ ^3F_3$	4.446	1.64[08]
$3p4d\ ^3P_1$	4.431	2.63[13]	$3p4s\ ^3P_2$	4.809	4.04[08]	$3p4d\ ^1F_3$	4.390	1.03[08]
$3p4d\ ^1P_1$	4.394	1.28[14]	$3p4d\ ^3F_2$	4.440	1.26[06]	$3p4d\ ^3D_3$	3.817	2.36[08]
$3p4d\ ^3D_1$	3.913	6.02[13]	$3p4d\ ^3P_2$	4.395	4.76[08]	$3s4f\ ^3F_3$	3.366	2.13[09]
$3s4p\ ^3P_1$	3.850	3.99[13]	$3p4d\ ^3D_2$	3.857	7.28[06]	$3s4f\ ^1F_3$	3.356	6.00[08]
$3s4p\ ^1P_1$	3.737	3.12[13]	$3p4d\ ^1D_2$	3.821	9.38[07]			
			$3s4p\ ^3P_2$	3.737	1.19[07]			
			$3s4f\ ^3F_2$	3.368	2.77[05]			

level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=79$ , even-parity states								
$3d4s\ ^3D_1$	6.360	4.15[04]	$3d4s\ ^3D_2$	6.666	9.27[09]	$3d4s\ ^3D_3$	6.673	2.01[04]
$3d4d\ ^3S_1$	5.457	1.58[08]	$3d4s\ ^1D_2$	6.356	7.01[09]	$3d4d\ ^3G_3$	5.436	3.63[03]
$3d4d\ ^1P_1$	5.380	8.22[07]	$3d4d\ ^3P_2$	5.442	8.07[09]	$3d4d\ ^3D_3$	5.365	2.16[05]
$3d4d\ ^3D_1$	5.237	2.77[07]	$3d4d\ ^3D_2$	5.362	4.02[10]	$3d4d\ ^3F_3$	5.237	4.41[03]
$3d4d\ ^3P_1$	5.174	4.26[07]	$3d4d\ ^3F_2$	5.223	2.73[10]	$3d4d\ ^1F_3$	5.158	1.26[03]
$3p4p\ ^3D_1$	5.002	9.64[08]	$3d4d\ ^1D_2$	5.162	1.02[10]	$3p4p\ ^3D_3$	4.726	3.20[05]
$3p4p\ ^3S_1$	4.726	4.94[07]	$3p4p\ ^3D_2$	5.000	4.53[10]	$3p4f\ ^3D_3$	4.139	6.09[04]
$3p4p\ ^1P_1$	4.271	8.48[06]	$3p4p\ ^1D_2$	4.716	4.67[10]	$3p4f\ ^3G_3$	4.131	3.79[06]
$3p4p\ ^3P_1$	4.154	7.59[06]	$3p4p\ ^3P_2$	4.146	1.42[09]	$3p4f\ ^3F_3$	3.619	1.25[06]
$3p4f\ ^3D_1$	4.076	6.55[08]	$3p4f\ ^3D_2$	4.120	9.30[11]	$3s4d\ ^3D_3$	3.530	2.17[06]
$3s4s\ ^3S_1$	4.039	4.14[08]	$3p4f\ ^1D_2$	4.063	2.36[10]			
$3s4d\ ^3D_1$	3.562	5.32[04]	$3p4f\ ^3F_2$	3.621	1.04[12]			
			$3s4d\ ^3D_2$	3.561	7.23[10]			
			$3s4d\ ^1D_2$	3.529	2.71[11]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=80$ , odd-parity states								
$3d4p\ ^3P_1$	5.817	1.10[13]	$3d4p\ ^3F_2$	6.106	9.34[06]	$3d4p\ ^3F_3$	6.102	8.40[06]
$3d4p\ ^3D_1$	5.663	1.90[13]	$3d4p\ ^3P_2$	5.827	4.15[05]	$3d4p\ ^1F_3$	5.657	1.01[07]
$3d4p\ ^1P_1$	5.427	1.94[12]	$3d4p\ ^1D_2$	5.666	3.33[07]	$3d4p\ ^3D_3$	5.426	1.79[07]
$3d4f\ ^3P_1$	5.066	3.35[13]	$3d4p\ ^3D_2$	5.419	9.81[02]	$3d4f\ ^3D_3$	4.831	8.51[07]
$3d4f\ ^3D_1$	4.848	8.96[10]	$3d4f\ ^3P_2$	5.074	6.98[07]	$3d4f\ ^3G_3$	4.809	7.27[07]
$3d4f\ ^1P_1$	4.778	2.28[14]	$3d4f\ ^3D_2$	4.837	1.83[08]	$3d4f\ ^3F_3$	4.649	8.51[07]
$3p4s\ ^1P_1$	4.615	5.41[14]	$3d4f\ ^1D_2$	4.822	2.23[09]	$3d4f\ ^1F_3$	4.638	1.69[07]
$3p4s\ ^3P_1$	4.309	3.98[12]	$3d4f\ ^3F_2$	4.660	7.53[07]	$3p4d\ ^3F_3$	4.307	1.86[08]
$3p4d\ ^3P_1$	4.277	3.73[13]	$3p4s\ ^3P_2$	4.650	4.56[08]	$3p4d\ ^1F_3$	4.251	1.18[08]
$3p4d\ ^1P_1$	4.254	1.28[14]	$3p4d\ ^3F_2$	4.301	1.30[06]	$3p4d\ ^3D_3$	3.681	2.77[08]
$3p4d\ ^3D_1$	3.780	8.86[13]	$3p4d\ ^3P_2$	4.256	5.38[08]	$3s4f\ ^3F_3$	3.252	2.41[09]
$3s4p\ ^3P_1$	3.715	4.50[13]	$3p4d\ ^3D_2$	3.720	7.98[06]	$3s4f\ ^1F_3$	3.242	7.31[08]
$3s4p\ ^1P_1$	3.605	2.57[13]	$3p4d\ ^1D_2$	3.685	1.02[08]			
			$3s4p\ ^3P_2$	3.606	3.78[07]			
			$3s4f\ ^3F_2$	3.254	3.41[05]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=80$ , even-parity states								
$3d4s\ ^3D_1$	6.149	4.96[04]	$3d4s\ ^3D_2$	6.453	1.03[10]	$3d4s\ ^3D_3$	6.460	2.38[04]
$3d4d\ ^3S_1$	5.279	1.86[08]	$3d4s\ ^1D_2$	6.145	7.76[09]	$3d4d\ ^3G_3$	5.258	4.19[03]
$3d4d\ ^1P_1$	5.201	9.84[07]	$3d4d\ ^3P_2$	5.264	9.13[09]	$3d4d\ ^3D_3$	5.188	2.57[05]
$3d4d\ ^3D_1$	5.061	3.11[07]	$3d4d\ ^3D_2$	5.184	4.46[10]	$3d4d\ ^3F_3$	5.060	5.16[03]
$3d4d\ ^3P_1$	4.997	4.75[07]	$3d4d\ ^3F_2$	5.047	3.05[10]	$3d4d\ ^1F_3$	4.982	1.55[03]
$3p4p\ ^3D_1$	4.852	1.13[09]	$3d4d\ ^1D_2$	4.986	1.12[10]	$3p4p\ ^3D_3$	4.574	3.79[05]
$3p4p\ ^3S_1$	4.574	5.90[07]	$3p4p\ ^3D_2$	4.850	4.99[10]	$3p4f\ ^3D_3$	4.011	5.67[04]
$3p4p\ ^1P_1$	4.122	9.92[06]	$3p4p\ ^1D_2$	4.565	5.17[10]	$3p4f\ ^3G_3$	4.002	4.47[06]
$3p4p\ ^3P_1$	4.025	8.41[06]	$3p4p\ ^3P_2$	4.017	7.53[08]	$3p4f\ ^3F_3$	3.492	1.36[06]
$3p4f\ ^3D_1$	3.932	6.26[08]	$3p4f\ ^3D_2$	3.992	1.02[12]	$3s4d\ ^3D_3$	3.408	2.59[06]
$3s4s\ ^3S_1$	3.898	6.34[08]	$3p4f\ ^1D_2$	3.916	3.10[10]			
$3s4d\ ^3D_1$	3.440	5.27[04]	$3p4f\ ^3F_2$	3.495	1.18[12]			
			$3s4d\ ^3D_2$	3.438	8.07[10]			
			$3s4d\ ^1D_2$	3.407	3.01[11]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=81$ , odd-parity states								
$3d4p\ ^3P_1$	5.631	1.17[13]	$3d4p\ ^3F_2$	5.919	1.10[07]	$3d4p\ ^3F_3$	5.915	9.48[06]
$3d4p\ ^3D_1$	5.476	2.04[13]	$3d4p\ ^3P_2$	5.641	4.76[05]	$3d4p\ ^1F_3$	5.470	1.16[07]
$3d4p\ ^1P_1$	5.241	1.99[12]	$3d4p\ ^1D_2$	5.478	3.90[07]	$3d4p\ ^3D_3$	5.241	2.07[07]
$3d4f\ ^3P_1$	4.915	3.75[13]	$3d4p\ ^3D_2$	5.234	2.51[02]	$3d4f\ ^3D_3$	4.678	9.30[07]
$3d4f\ ^3D_1$	4.695	2.72[10]	$3d4f\ ^3P_2$	4.922	8.42[07]	$3d4f\ ^3G_3$	4.656	8.61[07]
$3d4f\ ^1P_1$	4.626	2.48[14]	$3d4f\ ^3D_2$	4.684	1.85[08]	$3d4f\ ^3F_3$	4.498	9.65[07]
$3p4s\ ^1P_1$	4.465	5.69[14]	$3d4f\ ^1D_2$	4.669	2.57[09]	$3d4f\ ^1F_3$	4.487	2.07[07]
$3p4s\ ^3P_1$	4.175	1.00[13]	$3d4f\ ^3F_2$	4.508	9.64[07]	$3p4d\ ^3F_3$	4.174	2.10[08]
$3p4d\ ^3P_1$	4.130	7.62[13]	$3p4s\ ^3P_2$	4.497	5.16[08]	$3p4d\ ^1F_3$	4.118	1.35[08]
$3p4d\ ^1P_1$	4.120	8.50[13]	$3p4d\ ^3F_2$	4.169	1.34[06]	$3p4d\ ^3D_3$	3.552	3.23[08]
$3p4d\ ^3D_1$	3.646	1.12[14]	$3p4d\ ^3P_2$	4.123	6.41[08]	$3s4f\ ^3F_3$	3.143	2.73[09]
$3s4p\ ^3P_1$	3.584	5.00[13]	$3p4d\ ^3D_2$	3.590	8.82[06]	$3s4f\ ^1F_3$	3.133	8.86[08]
$3s4p\ ^1P_1$	3.478	2.27[13]	$3p4d\ ^1D_2$	3.555	1.17[08]			
			$3s4p\ ^3P_2$	3.481	5.64[08]			
			$3s4f\ ^3F_2$	3.145	4.29[05]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=81$ , even-parity states								
$3d4s\ ^3D_1$	5.949	5.90[04]	$3d4s\ ^3D_2$	6.252	1.14[10]	$3d4s\ ^3D_3$	6.258	2.81[04]
$3d4d\ ^3S_1$	5.109	2.18[08]	$3d4s\ ^1D_2$	5.945	8.59[09]	$3d4d\ ^3G_3$	5.089	4.82[03]
$3d4d\ ^1P_1$	5.032	1.17[08]	$3d4d\ ^3P_2$	5.094	1.03[10]	$3d4d\ ^3D_3$	5.019	3.05[05]
$3d4d\ ^3D_1$	4.892	3.48[07]	$3d4d\ ^3D_2$	5.016	4.94[10]	$3d4d\ ^3F_3$	4.892	6.03[03]
$3d4d\ ^3P_1$	4.829	5.22[07]	$3d4d\ ^3F_2$	4.879	3.39[10]	$3d4d\ ^1F_3$	4.815	1.88[03]
$3p4p\ ^3D_1$	4.708	1.32[09]	$3d4d\ ^1D_2$	4.819	1.22[10]	$3p4p\ ^3D_3$	4.430	4.47[05]
$3p4p\ ^3S_1$	4.430	7.03[07]	$3p4p\ ^3D_2$	4.706	5.49[10]	$3p4f\ ^3D_3$	3.888	5.25[04]
$3p4p\ ^1P_1$	3.980	1.15[07]	$3p4p\ ^1D_2$	4.421	5.71[10]	$3p4f\ ^3G_3$	3.880	5.26[06]
$3p4p\ ^3P_1$	3.902	9.58[06]	$3p4p\ ^3P_2$	3.895	2.91[08]	$3p4f\ ^3F_3$	3.371	1.37[06]
$3p4f\ ^3D_1$	3.795	5.31[08]	$3p4f\ ^3D_2$	3.870	1.11[12]	$3s4d\ ^3D_3$	3.292	3.08[06]
$3s4s\ ^3S_1$	3.763	9.52[08]	$3p4f\ ^1D_2$	3.775	4.02[10]			
$3s4d\ ^3D_1$	3.323	4.78[04]	$3p4f\ ^3F_2$	3.375	1.35[12]			
			$3s4d\ ^3D_2$	3.322	9.03[10]			
			$3s4d\ ^1D_2$	3.291	3.34[11]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=82$ , odd-parity states								
$3d4p\ ^3P_1$	5.455	1.25[13]	$3d4p\ ^3F_2$	5.741	1.25[07]	$3d4p\ ^3F_3$	5.737	1.07[07]
$3d4p\ ^3D_1$	5.298	2.20[13]	$3d4p\ ^3P_2$	5.464	5.71[05]	$3d4p\ ^1F_3$	5.292	1.32[07]
$3d4p\ ^1P_1$	5.064	2.06[12]	$3d4p\ ^1D_2$	5.300	4.43[07]	$3d4p\ ^3D_3$	5.064	2.38[07]
$3d4f\ ^3P_1$	4.772	3.91[13]	$3d4p\ ^3D_2$	5.058	8.60[02]	$3d4f\ ^3D_3$	4.533	1.02[08]
$3d4f\ ^3D_1$	4.549	3.20[11]	$3d4f\ ^3P_2$	4.778	9.41[07]	$3d4f\ ^3G_3$	4.511	1.01[08]
$3d4f\ ^1P_1$	4.482	2.72[14]	$3d4f\ ^3D_2$	4.538	1.87[08]	$3d4f\ ^3F_3$	4.354	1.09[08]
$3p4s\ ^1P_1$	4.323	6.01[14]	$3d4f\ ^1D_2$	4.523	2.95[09]	$3d4f\ ^1F_3$	4.342	2.51[07]
$3p4s\ ^3P_1$	4.040	1.01[13]	$3d4f\ ^3F_2$	4.363	1.22[08]	$3p4d\ ^3F_3$	4.047	2.37[08]
$3p4d\ ^3P_1$	3.997	1.43[14]	$3p4s\ ^3P_2$	4.352	5.81[08]	$3p4d\ ^1F_3$	3.991	1.55[08]
$3p4d\ ^1P_1$	3.981	1.83[13]	$3p4d\ ^3F_2$	4.042	1.38[06]	$3p4d\ ^3D_3$	3.428	3.76[08]
$3p4d\ ^3D_1$	3.520	1.05[14]	$3p4d\ ^3P_2$	3.996	7.23[08]	$3s4f\ ^3F_3$	3.039	3.09[09]
$3s4p\ ^3P_1$	3.453	5.51[13]	$3p4d\ ^3D_2$	3.466	9.30[06]	$3s4f\ ^1F_3$	3.029	1.07[09]
$3s4p\ ^1P_1$	3.360	1.94[13]	$3p4d\ ^1D_2$	3.431	1.32[08]			
			$3s4p\ ^3P_2$	3.361	2.24[08]			
			$3s4f\ ^3F_2$	3.041	5.69[05]			

level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=82$ , even-parity states								
$3d4s\ ^3D_1$	5.759	7.01[04]	$3d4s\ ^3D_2$	6.061	1.26[10]	$3d4s\ ^3D_3$	6.068	3.29[04]
$3d4d\ ^3S_1$	4.947	2.55[08]	$3d4s\ ^1D_2$	5.755	9.48[09]	$3d4d\ ^3G_3$	4.928	5.53[03]
$3d4d\ ^1P_1$	4.870	1.40[08]	$3d4d\ ^3P_2$	4.933	1.16[10]	$3d4d\ ^3D_3$	4.858	3.60[05]
$3d4d\ ^3D_1$	4.733	3.84[07]	$3d4d\ ^3D_2$	4.855	5.46[10]	$3d4d\ ^3F_3$	4.732	7.03[03]
$3d4d\ ^3P_1$	4.669	5.59[07]	$3d4d\ ^3F_2$	4.720	3.78[10]	$3d4d\ ^1F_3$	4.656	2.26[03]
$3p4p\ ^3D_1$	4.571	1.54[09]	$3d4d\ ^1D_2$	4.659	1.31[10]	$3p4p\ ^3D_3$	4.292	5.25[05]
$3p4p\ ^3S_1$	4.292	8.34[07]	$3p4p\ ^3D_2$	4.570	6.02[10]	$3p4f\ ^3D_3$	3.772	4.82[04]
$3p4p\ ^1P_1$	3.845	1.32[07]	$3p4p\ ^1D_2$	4.283	6.30[10]	$3p4f\ ^3G_3$	3.763	6.16[06]
$3p4p\ ^3P_1$	3.785	1.11[07]	$3p4p\ ^3P_2$	3.778	3.71[07]	$3p4f\ ^3F_3$	3.256	1.14[06]
$3p4f\ ^3D_1$	3.666	3.93[08]	$3p4f\ ^3D_2$	3.753	1.22[12]	$3s4d\ ^3D_3$	3.180	3.66[06]
$3s4s\ ^3S_1$	3.633	1.35[09]	$3p4f\ ^1D_2$	3.642	4.82[10]			
$3s4d\ ^3D_1$	3.212	3.71[04]	$3p4f\ ^3F_2$	3.260	1.58[12]			
			$3s4d\ ^3D_2$	3.210	1.00[11]			
			$3s4d\ ^1D_2$	3.179	3.69[11]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=83$ , odd-parity states								
$3d4p\ ^3P_1$	5.287	1.38[13]	$3d4p\ ^3F_2$	5.572	1.42[07]	$3d4p\ ^3F_3$	5.568	1.20[07]
$3d4p\ ^3D_1$	5.128	2.32[13]	$3d4p\ ^3P_2$	5.296	6.75[05]	$3d4p\ ^1F_3$	5.123	1.51[07]
$3d4p\ ^1P_1$	4.897	2.10[12]	$3d4p\ ^1D_2$	5.131	5.06[07]	$3d4p\ ^3D_3$	4.896	2.73[07]
$3d4f\ ^3P_1$	4.634	4.08[13]	$3d4p\ ^3D_2$	4.891	3.18[03]	$3d4f\ ^3D_3$	4.394	1.11[08]
$3d4f\ ^3D_1$	4.410	1.50[10]	$3d4f\ ^3P_2$	4.640	1.06[08]	$3d4f\ ^3G_3$	4.372	1.18[08]
$3d4f\ ^1P_1$	4.344	3.01[14]	$3d4f\ ^3D_2$	4.400	1.88[08]	$3d4f\ ^3F_3$	4.216	1.23[08]
$3p4s\ ^1P_1$	4.187	6.35[14]	$3d4f\ ^1D_2$	4.384	3.37[09]	$3d4f\ ^1F_3$	4.204	3.03[07]
$3p4s\ ^3P_1$	3.927	1.05[13]	$3d4f\ ^3F_2$	4.225	1.51[08]	$3p4d\ ^3F_3$	3.926	2.67[08]
$3p4d\ ^3P_1$	3.875	1.90[14]	$3p4s\ ^3P_2$	4.214	6.53[08]	$3p4d\ ^1F_3$	3.870	1.76[08]
$3p4d\ ^1P_1$	3.849	3.31[11]	$3p4d\ ^3F_2$	3.921	1.42[06]	$3p4d\ ^3D_3$	3.309	4.35[08]
$3p4d\ ^3D_1$	3.417	1.53[14]	$3p4d\ ^3P_2$	3.875	8.22[08]	$3s4f\ ^3F_3$	2.939	3.50[09]
$3s4p\ ^3P_1$	3.343	6.00[13]	$3p4d\ ^3D_2$	3.347	1.00[07]	$3s4f\ ^1F_3$	2.929	1.28[09]
$3s4p\ ^1P_1$	3.246	1.96[13]	$3p4d\ ^1D_2$	3.312	1.57[08]			
			$3s4p\ ^3P_2$	3.247	1.87[08]			
			$3s4f\ ^3F_2$	2.941	7.94[05]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=83$ , even-parity states								
$3d4s\ ^3D_1$	5.579	8.31[04]	$3d4s\ ^3D_2$	5.880	1.39[10]	$3d4s\ ^3D_3$	5.886	3.85[04]
$3d4d\ ^3S_1$	4.793	2.97[08]	$3d4s\ ^1D_2$	5.576	1.04[10]	$3d4d\ ^3G_3$	4.775	6.33[03]
$3d4d\ ^1P_1$	4.717	1.65[08]	$3d4d\ ^3P_2$	4.780	1.31[10]	$3d4d\ ^3D_3$	4.705	4.24[05]
$3d4d\ ^3D_1$	4.580	4.19[07]	$3d4d\ ^3D_2$	4.702	6.03[10]	$3d4d\ ^3F_3$	4.580	8.18[03]
$3d4d\ ^3P_1$	4.517	5.72[07]	$3d4d\ ^3F_2$	4.568	4.22[10]	$3d4d\ ^1F_3$	4.504	2.77[03]
$3p4p\ ^3D_1$	4.441	1.80[09]	$3d4d\ ^1D_2$	4.507	1.39[10]	$3p4p\ ^3D_3$	4.161	6.16[05]
$3p4p\ ^3S_1$	4.160	9.87[07]	$3p4p\ ^3D_2$	4.440	6.61[10]	$3p4f\ ^3D_3$	3.660	4.44[04]
$3p4p\ ^1P_1$	3.716	1.49[07]	$3p4p\ ^1D_2$	4.152	6.94[10]	$3p4f\ ^3G_3$	3.651	7.18[06]
$3p4p\ ^3P_1$	3.672	1.33[07]	$3p4p\ ^3P_2$	3.665	3.27[07]	$3p4f\ ^3F_3$	3.146	4.34[05]
$3p4f\ ^3D_1$	3.543	2.61[08]	$3p4f\ ^3D_2$	3.642	1.33[12]	$3s4d\ ^3D_3$	3.074	4.33[06]
$3s4s\ ^3S_1$	3.507	1.78[09]	$3p4f\ ^1D_2$	3.514	5.65[10]			
$3s4d\ ^3D_1$	3.105	2.01[04]	$3p4f\ ^3F_2$	3.150	1.72[12]			
			$3s4d\ ^3D_2$	3.103	1.10[11]			
			$3s4d\ ^1D_2$	3.072	4.07[11]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=84$ , odd-parity states								
$3d4p\ ^3P_1$	5.127	1.49[13]	$3d4p\ ^3F_2$	5.411	1.61[07]	$3d4p\ ^3F_3$	5.408	1.34[07]
$3d4p\ ^3D_1$	4.967	2.46[13]	$3d4p\ ^3P_2$	5.136	7.93[05]	$3d4p\ ^1F_3$	4.962	1.72[07]
$3d4p\ ^1P_1$	4.737	2.22[12]	$3d4p\ ^1D_2$	4.969	5.77[07]	$3d4p\ ^3D_3$	4.737	3.13[07]
$3d4f\ ^3P_1$	4.503	4.30[13]	$3d4p\ ^3D_2$	4.731	8.59[03]	$3d4f\ ^3D_3$	4.262	1.21[08]
$3d4f\ ^3D_1$	4.277	6.37[09]	$3d4f\ ^3P_2$	4.509	1.21[08]	$3d4f\ ^3G_3$	4.240	1.38[08]
$3d4f\ ^1P_1$	4.212	3.30[14]	$3d4f\ ^3D_2$	4.267	1.90[08]	$3d4f\ ^3F_3$	4.085	1.39[08]
$3p4s\ ^1P_1$	4.057	6.69[14]	$3d4f\ ^1D_2$	4.252	3.84[09]	$3d4f\ ^1F_3$	4.073	3.63[07]
$3p4s\ ^3P_1$	3.811	1.12[13]	$3d4f\ ^3F_2$	4.093	1.85[08]	$3p4d\ ^3F_3$	3.810	3.00[08]
$3p4d\ ^3P_1$	3.759	2.01[14]	$3p4s\ ^3P_2$	4.082	7.34[08]	$3p4d\ ^1F_3$	3.755	2.01[08]
$3p4d\ ^1P_1$	3.721	2.70[12]	$3p4d\ ^3F_2$	3.805	1.46[06]	$3p4d\ ^3D_3$	3.196	5.02[08]
$3p4d\ ^3D_1$	3.309	7.94[13]	$3p4d\ ^3P_2$	3.759	9.34[08]	$3s4f\ ^3F_3$	2.843	3.98[09]
$3s4p\ ^3P_1$	3.231	6.53[13]	$3p4d\ ^3D_2$	3.235	1.62[07]	$3s4f\ ^1F_3$	2.834	1.52[09]
$3s4p\ ^1P_1$	3.137	1.97[13]	$3p4d\ ^1D_2$	3.199	1.78[08]			
			$3s4p\ ^3P_2$	3.138	1.82[08]			
			$3s4f\ ^3F_2$	2.845	1.19[06]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=84$ , even-parity states								
$3d4s\ ^3D_1$	5.408	9.82[04]	$3d4s\ ^3D_2$	5.709	1.53[10]	$3d4s\ ^3D_3$	5.714	4.48[04]
$3d4d\ ^3S_1$	4.646	3.47[08]	$3d4s\ ^1D_2$	5.405	1.15[10]	$3d4d\ ^3G_3$	4.629	7.18[03]
$3d4d\ ^1P_1$	4.570	1.95[08]	$3d4d\ ^3P_2$	4.634	1.47[10]	$3d4d\ ^3D_3$	4.559	4.98[05]
$3d4d\ ^3D_1$	4.435	4.50[07]	$3d4d\ ^3D_2$	4.556	6.64[10]	$3d4d\ ^3F_3$	4.435	9.47[03]
$3d4d\ ^3P_1$	4.372	5.34[07]	$3d4d\ ^3F_2$	4.424	4.72[10]	$3d4d\ ^1F_3$	4.360	3.43[03]
$3p4p\ ^3D_1$	4.316	2.10[09]	$3d4d\ ^1D_2$	4.363	1.43[10]	$3p4p\ ^3D_3$	4.035	7.18[05]
$3p4p\ ^3S_1$	4.035	1.16[08]	$3p4p\ ^3D_2$	4.315	7.27[10]	$3p4f\ ^3D_3$	3.553	4.07[04]
$3p4p\ ^1P_1$	3.593	1.59[07]	$3p4p\ ^1D_2$	4.027	7.64[10]	$3p4f\ ^3G_3$	3.543	8.29[06]
$3p4p\ ^3P_1$	3.565	1.68[07]	$3p4p\ ^3P_2$	3.558	3.54[08]	$3p4f\ ^3F_3$	3.040	1.34[06]
$3p4f\ ^3D_1$	3.426	1.60[08]	$3p4f\ ^3D_2$	3.535	1.45[12]	$3s4d\ ^3D_3$	2.972	5.14[06]
$3s4s\ ^3S_1$	3.387	2.23[09]	$3p4f\ ^1D_2$	3.392	6.68[10]			
$3s4d\ ^3D_1$	3.002	2.36[03]	$3p4f\ ^3F_2$	3.044	1.93[12]			
			$3s4d\ ^3D_2$	3.001	1.14[11]			
			$3s4d\ ^1D_2$	2.970	4.46[11]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=85$ , odd-parity states								
$3d4p\ ^3P_1$	4.975	1.60[13]	$3d4p\ ^3F_2$	5.258	1.83[07]	$3d4p\ ^3F_3$	5.255	1.49[07]
$3d4p\ ^3D_1$	4.813	2.62[13]	$3d4p\ ^3P_2$	4.984	9.28[05]	$3d4p\ ^1F_3$	4.808	1.95[07]
$3d4p\ ^1P_1$	4.586	2.28[12]	$3d4p\ ^1D_2$	4.816	6.57[07]	$3d4p\ ^3D_3$	4.585	3.58[07]
$3d4f\ ^3P_1$	4.378	4.57[13]	$3d4p\ ^3D_2$	4.580	1.96[04]	$3d4f\ ^3D_3$	4.135	1.32[08]
$3d4f\ ^3D_1$	4.150	3.38[08]	$3d4f\ ^3P_2$	4.384	1.36[08]	$3d4f\ ^3G_3$	4.114	1.59[08]
$3d4f\ ^1P_1$	4.087	3.61[14]	$3d4f\ ^3D_2$	4.140	1.92[08]	$3d4f\ ^3F_3$	3.959	1.57[08]
$3p4s\ ^1P_1$	3.933	7.06[14]	$3d4f\ ^1D_2$	4.125	4.37[09]	$3d4f\ ^1F_3$	3.947	4.32[07]
$3p4s\ ^3P_1$	3.700	1.25[13]	$3d4f\ ^3F_2$	3.967	2.24[08]	$3p4d\ ^3F_3$	3.699	3.37[08]
$3p4d\ ^3P_1$	3.648	2.13[14]	$3p4s\ ^3P_2$	3.956	8.23[08]	$3p4d\ ^1F_3$	3.644	2.28[08]
$3p4d\ ^1P_1$	3.597	4.80[12]	$3p4d\ ^3F_2$	3.695	1.50[06]	$3p4d\ ^3D_3$	3.088	5.79[08]
$3p4d\ ^3D_1$	3.204	7.12[13]	$3p4d\ ^3P_2$	3.648	1.06[09]	$3s4f\ ^3F_3$	2.752	4.66[09]
$3s4p\ ^3P_1$	3.119	7.22[13]	$3p4d\ ^3D_2$	3.123	2.26[07]	$3s4f\ ^1F_3$	2.742	1.78[09]
$3s4p\ ^1P_1$	3.032	2.43[13]	$3p4d\ ^1D_2$	3.090	2.01[08]			
			$3s4p\ ^3P_2$	3.033	1.77[08]			
			$3s4f\ ^3F_2$	2.753	1.98[06]			



level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=85$ , even-parity states								
$3d4s\ ^3D_1$	5.246	1.16[05]	$3d4s\ ^3D_2$	5.546	1.68[10]	$3d4s\ ^3D_3$	5.551	5.27[04]
$3d4d\ ^3S_1$	4.507	4.04[08]	$3d4s\ ^1D_2$	5.243	1.26[10]	$3d4d\ ^3G_3$	4.490	8.81[03]
$3d4d\ ^1P_1$	4.431	2.30[08]	$3d4d\ ^3P_2$	4.495	1.65[10]	$3d4d\ ^3D_3$	4.420	5.90[05]
$3d4d\ ^3D_1$	4.297	4.69[07]	$3d4d\ ^3D_2$	4.417	7.31[10]	$3d4d\ ^3F_3$	4.296	1.11[04]
$3d4d\ ^3P_1$	4.234	3.85[07]	$3d4d\ ^3F_2$	4.286	5.32[10]	$3d4d\ ^1F_3$	4.222	4.39[03]
$3p4p\ ^3D_1$	4.197	2.45[09]	$3d4d\ ^1D_2$	4.225	1.37[10]	$3p4p\ ^3D_3$	3.915	8.65[05]
$3p4p\ ^3S_1$	3.915	1.37[08]	$3p4p\ ^3D_2$	4.196	8.06[10]	$3p4f\ ^3D_3$	3.450	3.75[04]
$3p4p\ ^1P_1$	3.476	1.30[07]	$3p4p\ ^1D_2$	3.907	8.41[10]	$3p4f\ ^3G_3$	3.441	1.03[07]
$3p4p\ ^3P_1$	3.461	2.49[07]	$3p4p\ ^3P_2$	3.455	7.21[08]	$3p4f\ ^3F_3$	2.939	2.07[08]
$3p4f\ ^3D_1$	3.315	9.29[07]	$3p4f\ ^3D_2$	3.433	1.58[12]	$3s4d\ ^3D_3$	2.872	6.06[06]
$3s4s\ ^3S_1$	3.271	2.70[09]	$3p4f\ ^1D_2$	3.275	7.67[10]			
$3s4d\ ^3D_1$	2.903	1.50[04]	$3p4f\ ^3F_2$	2.943	2.12[12]			
			$3s4d\ ^3D_2$	2.902	1.38[11]			
			$3s4d\ ^1D_2$	2.871	4.78[11]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=86$ , odd-parity states								
$3d4p\ ^3P_1$	4.831	1.72[13]	$3d4p\ ^3F_2$	5.113	2.07[07]	$3d4p\ ^3F_3$	5.110	1.66[07]
$3d4p\ ^3D_1$	4.667	2.78[13]	$3d4p\ ^3P_2$	4.839	1.08[06]	$3d4p\ ^1F_3$	4.662	2.21[07]
$3d4p\ ^1P_1$	4.441	2.34[12]	$3d4p\ ^1D_2$	4.669	7.46[07]	$3d4p\ ^3D_3$	4.440	4.09[07]
$3d4f\ ^3P_1$	4.258	4.86[13]	$3d4p\ ^3D_2$	4.435	4.06[04]	$3d4f\ ^3D_3$	4.015	1.43[08]
$3d4f\ ^3D_1$	4.028	2.25[09]	$3d4f\ ^3P_2$	4.264	1.54[08]	$3d4f\ ^3G_3$	3.993	1.83[08]
$3d4f\ ^1P_1$	3.967	3.94[14]	$3d4f\ ^3D_2$	4.019	1.93[08]	$3d4f\ ^3F_3$	3.840	1.76[08]
$3p4s\ ^1P_1$	3.815	7.43[14]	$3d4f\ ^1D_2$	4.004	4.96[09]	$3d4f\ ^1F_3$	3.827	5.12[07]
$3p4s\ ^3P_1$	3.594	1.39[13]	$3d4f\ ^3F_2$	3.847	2.68[08]	$3p4d\ ^3F_3$	3.592	3.76[08]
$3p4d\ ^3P_1$	3.542	2.25[14]	$3p4s\ ^3P_2$	3.836	9.23[08]	$3p4d\ ^1F_3$	3.538	2.58[08]
$3p4d\ ^1P_1$	3.479	6.55[12]	$3p4d\ ^3F_2$	3.588	1.54[06]	$3p4d\ ^3D_3$	2.984	6.66[08]
$3p4d\ ^3D_1$	3.103	6.84[13]	$3p4d\ ^3P_2$	3.542	1.20[09]	$3s4f\ ^3F_3$	2.661	5.08[09]
$3s4p\ ^3P_1$	3.016	7.71[13]	$3p4d\ ^3D_2$	3.019	2.81[07]	$3s4f\ ^1F_3$	2.653	2.37[09]
$3s4p\ ^1P_1$	2.932	2.86[13]	$3p4d\ ^1D_2$	2.986	2.38[08]			
			$3s4p\ ^3P_2$	2.933	1.67[08]			
			$3s4f\ ^3F_2$	2.664	4.12[06]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=86$ , even-parity states								
$3d4s\ ^3D_1$	5.091	1.37[05]	$3d4s\ ^3D_2$	5.391	1.83[10]	$3d4s\ ^3D_3$	5.396	6.06[04]
$3d4d\ ^3S_1$	4.373	4.71[08]	$3d4s\ ^1D_2$	5.088	1.38[10]	$3d4d\ ^3G_3$	4.357	9.64[03]
$3d4d\ ^1P_1$	4.297	2.71[08]	$3d4d\ ^3P_2$	4.362	1.85[10]	$3d4d\ ^3D_3$	4.287	6.85[05]
$3d4d\ ^3D_1$	4.165	4.67[07]	$3d4d\ ^3D_2$	4.284	8.13[10]	$3d4d\ ^3F_3$	4.164	1.28[04]
$3d4d\ ^3P_1$	4.102	5.26[06]	$3d4d\ ^3F_2$	4.155	6.01[10]	$3d4d\ ^1F_3$	4.090	5.38[03]
$3p4p\ ^3D_1$	4.083	2.87[09]	$3d4d\ ^1D_2$	4.094	3.27[09]	$3p4p\ ^3D_3$	3.800	9.89[05]
$3p4p\ ^3S_1$	3.800	1.60[08]	$3p4p\ ^3D_2$	4.082	9.88[10]	$3p4f\ ^3D_3$	3.352	3.41[04]
$3p4p\ ^1P_1$	3.366	1.17[05]	$3p4p\ ^1D_2$	3.793	9.19[10]	$3p4f\ ^3G_3$	3.343	1.15[07]
$3p4p\ ^3P_1$	3.359	3.38[07]	$3p4p\ ^3P_2$	3.357	1.18[09]	$3p4f\ ^3F_3$	2.842	2.84[07]
$3p4f\ ^3D_1$	3.209	5.00[07]	$3p4f\ ^3D_2$	3.336	1.76[12]	$3s4d\ ^3D_3$	2.778	7.14[06]
$3s4s\ ^3S_1$	3.161	3.20[09]	$3p4f\ ^1D_2$	3.164	8.79[10]			
$3s4d\ ^3D_1$	2.809	2.09[05]	$3p4f\ ^3F_2$	2.846	2.21[12]			
			$3s4d\ ^3D_2$	2.808	1.87[11]			
			$3s4d\ ^1D_2$	2.778	6.67[11]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=87$ , odd-parity states								
$3d4p\ ^3P_1$	4.693	1.85[13]	$3d4p\ ^3F_2$	4.975	2.35[07]	$3d4p\ ^3F_3$	4.972	1.84[07]
$3d4p\ ^3D_1$	4.527	2.96[13]	$3d4p\ ^3P_2$	4.701	1.25[06]	$3d4p\ ^1F_3$	4.523	2.50[07]
$3d4p\ ^1P_1$	4.303	2.37[12]	$3d4p\ ^1D_2$	4.529	8.49[07]	$3d4p\ ^3D_3$	4.302	4.65[07]
$3d4f\ ^3P_1$	4.144	5.18[13]	$3d4p\ ^3D_2$	4.297	1.01[05]	$3d4f\ ^3D_3$	3.899	1.57[08]
$3d4f\ ^3D_1$	3.912	1.42[10]	$3d4f\ ^3P_2$	4.150	1.74[08]	$3d4f\ ^3G_3$	3.878	2.11[08]
$3d4f\ ^1P_1$	3.852	4.28[14]	$3d4f\ ^3D_2$	3.904	1.95[08]	$3d4f\ ^3F_3$	3.725	1.98[08]
$3p4s\ ^1P_1$	3.702	7.82[14]	$3d4f\ ^1D_2$	3.888	5.61[09]	$3d4f\ ^1F_3$	3.712	6.02[07]
$3p4s\ ^3P_1$	3.492	1.54[13]	$3d4f\ ^3F_2$	3.732	3.16[08]	$3p4d\ ^3F_3$	3.491	4.22[08]
$3p4d\ ^3P_1$	3.440	2.39[14]	$3p4s\ ^3P_2$	3.721	1.04[09]	$3p4d\ ^1F_3$	3.436	2.93[08]
$3p4d\ ^1P_1$	3.366	8.09[12]	$3p4d\ ^3F_2$	3.487	1.58[06]	$3p4d\ ^3D_3$	2.884	7.39[08]
$3p4d\ ^3D_1$	3.006	6.89[13]	$3p4d\ ^3P_2$	3.440	1.36[09]	$3s4f\ ^3F_3$	2.578	5.42[09]
$3s4p\ ^3P_1$	2.916	8.24[13]	$3p4d\ ^3D_2$	2.920	3.41[07]	$3s4f\ ^1F_3$	2.569	2.61[09]
$3s4p\ ^1P_1$	2.836	3.27[13]	$3p4d\ ^1D_2$	2.886	2.68[08]			
			$3s4p\ ^3P_2$	2.837	1.56[08]			
			$3s4f\ ^3F_2$	2.580	1.73[07]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=87$ , even-parity states								
$3d4s\ ^3D_1$	4.944	1.61[05]	$3d4s\ ^3D_2$	5.243	1.99[10]	$3d4s\ ^3D_3$	5.248	6.99[04]
$3d4d\ ^3S_1$	4.246	5.47[08]	$3d4s\ ^1D_2$	4.941	1.50[10]	$3d4d\ ^3G_3$	4.230	1.09[04]
$3d4d\ ^1P_1$	4.170	3.17[08]	$3d4d\ ^3P_2$	4.235	2.03[10]	$3d4d\ ^3D_3$	4.160	7.98[05]
$3d4d\ ^3D_1$	4.039	4.26[07]	$3d4d\ ^3D_2$	4.158	8.76[10]	$3d4d\ ^3F_3$	4.038	1.47[04]
$3d4d\ ^3P_1$	3.980	3.58[08]	$3d4d\ ^3F_2$	4.029	6.61[10]	$3d4d\ ^1F_3$	3.965	6.38[03]
$3p4p\ ^3D_1$	3.971	2.96[09]	$3d4d\ ^1D_2$	3.975	2.93[10]	$3p4p\ ^3D_3$	3.690	1.15[06]
$3p4p\ ^3S_1$	3.690	1.88[08]	$3p4p\ ^3D_2$	3.967	7.81[10]	$3p4f\ ^3D_3$	3.258	3.27[04]
$3p4p\ ^1P_1$	3.270	8.75[06]	$3p4p\ ^1D_2$	3.683	9.99[10]	$3p4f\ ^3G_3$	3.248	1.32[07]
$3p4p\ ^3P_1$	3.253	4.22[07]	$3p4p\ ^3P_2$	3.263	2.54[09]	$3p4f\ ^3F_3$	2.749	2.05[07]
$3p4f\ ^3D_1$	3.107	2.40[07]	$3p4f\ ^3D_2$	3.241	1.91[12]	$3s4d\ ^3D_3$	2.688	8.38[06]
$3s4s\ ^3S_1$	3.054	3.78[09]	$3p4f\ ^1D_2$	3.054	9.81[10]			
$3s4d\ ^3D_1$	2.718	1.51[06]	$3p4f\ ^3F_2$	2.754	2.34[12]			
			$3s4d\ ^3D_2$	2.717	2.39[11]			
			$3s4d\ ^1D_2$	2.687	6.60[11]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=88$ , odd-parity states								
$3d4p\ ^3P_1$	4.562	1.99[13]	$3d4p\ ^3F_2$	4.843	2.64[07]	$3d4p\ ^3F_3$	4.841	2.04[07]
$3d4p\ ^3D_1$	4.394	3.14[13]	$3d4p\ ^3P_2$	4.570	1.48[06]	$3d4p\ ^1F_3$	4.390	2.82[07]
$3d4p\ ^1P_1$	4.171	2.36[12]	$3d4p\ ^1D_2$	4.396	9.60[07]	$3d4p\ ^3D_3$	4.170	5.28[07]
$3d4f\ ^3P_1$	4.035	5.51[13]	$3d4p\ ^3D_2$	4.166	1.66[05]	$3d4f\ ^3D_3$	3.789	1.70[08]
$3d4f\ ^3D_1$	3.801	3.84[10]	$3d4f\ ^3P_2$	4.041	1.96[08]	$3d4f\ ^3G_3$	3.767	2.41[08]
$3d4f\ ^1P_1$	3.742	4.65[14]	$3d4f\ ^3D_2$	3.793	1.97[08]	$3d4f\ ^3F_3$	3.615	2.21[08]
$3p4s\ ^1P_1$	3.593	8.22[14]	$3d4f\ ^1D_2$	3.777	6.33[09]	$3d4f\ ^1F_3$	3.602	7.06[07]
$3p4s\ ^3P_1$	3.394	1.69[13]	$3d4f\ ^3F_2$	3.622	3.75[08]	$3p4d\ ^3F_3$	3.393	4.71[08]
$3p4d\ ^3P_1$	3.342	2.53[14]	$3p4s\ ^3P_2$	3.610	1.16[09]	$3p4d\ ^1F_3$	3.339	3.30[08]
$3p4d\ ^1P_1$	3.257	9.50[12]	$3p4d\ ^3F_2$	3.389	1.62[06]	$3p4d\ ^3D_3$	2.789	8.70[08]
$3p4d\ ^3D_1$	2.913	7.10[13]	$3p4d\ ^3P_2$	3.342	1.53[09]	$3s4f\ ^3F_3$	2.497	6.03[09]
$3s4p\ ^3P_1$	2.821	8.84[13]	$3p4d\ ^3D_2$	2.824	4.05[07]	$3s4f\ ^1F_3$	2.488	3.18[09]
$3s4p\ ^1P_1$	2.743	3.71[13]	$3p4d\ ^1D_2$	2.791	2.99[08]			
			$3s4p\ ^3P_2$	2.744	1.72[08]			
			$3s4f\ ^3F_2$	2.498	1.78[08]			

level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=88$ , even-parity states								
$3d4s\ ^3D_1$	4.804	1.92[05]	$3d4s\ ^3D_2$	5.103	2.18[10]	$3d4s\ ^3D_3$	5.108	8.04[04]
$3d4d\ ^3S_1$	4.124	6.37[08]	$3d4s\ ^1D_2$	4.801	1.65[10]	$3d4d\ ^3G_3$	4.109	1.24[04]
$3d4d\ ^1P_1$	4.048	3.71[08]	$3d4d\ ^3P_2$	4.113	2.27[10]	$3d4d\ ^3D_3$	4.039	9.27[05]
$3d4d\ ^3D_1$	3.918	3.19[07]	$3d4d\ ^3D_2$	4.036	9.60[10]	$3d4d\ ^3F_3$	3.917	1.69[04]
$3d4d\ ^3P_1$	3.873	2.91[09]	$3d4d\ ^3F_2$	3.909	7.78[10]	$3d4d\ ^1F_3$	3.845	7.47[03]
$3p4p\ ^3D_1$	3.854	9.18[08]	$3d4d\ ^1D_2$	3.871	7.28[10]	$3p4p\ ^3D_3$	3.585	1.33[06]
$3p4p\ ^3S_1$	3.584	2.19[08]	$3p4p\ ^3D_2$	3.847	4.94[10]	$3p4f\ ^3D_3$	3.168	2.85[04]
$3p4p\ ^1P_1$	3.179	1.37[07]	$3p4p\ ^1D_2$	3.578	1.10[11]	$3p4f\ ^3G_3$	3.158	1.53[07]
$3p4p\ ^3P_1$	3.149	4.54[07]	$3p4p\ ^3P_2$	3.172	4.79[09]	$3p4f\ ^3F_3$	2.659	1.93[07]
$3p4f\ ^3D_1$	3.009	8.62[06]	$3p4f\ ^3D_2$	3.150	2.07[12]	$3s4d\ ^3D_3$	2.601	9.83[06]
$3s4s\ ^3S_1$	2.952	4.40[09]	$3p4f\ ^1D_2$	2.953	1.01[11]			
$3s4d\ ^3D_1$	2.632	1.55[07]	$3p4f\ ^3F_2$	2.665	2.22[12]			
			$3s4d\ ^3D_2$	2.631	2.74[11]			
			$3s4d\ ^1D_2$	2.601	7.05[11]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=89$ , odd-parity states								
$3d4p\ ^3P_1$	4.437	2.13[13]	$3d4p\ ^3F_2$	4.718	2.97[07]	$3d4p\ ^3F_3$	4.715	2.25[07]
$3d4p\ ^3D_1$	4.266	3.34[13]	$3d4p\ ^3P_2$	4.444	1.69[06]	$3d4p\ ^1F_3$	4.262	3.18[07]
$3d4p\ ^1P_1$	4.045	2.31[12]	$3d4p\ ^1D_2$	4.269	1.09[08]	$3d4p\ ^3D_3$	4.044	5.98[07]
$3d4f\ ^3P_1$	3.931	5.87[13]	$3d4p\ ^3D_2$	4.040	3.21[05]	$3d4f\ ^3D_3$	3.683	1.86[08]
$3d4f\ ^3D_1$	3.695	7.73[10]	$3d4f\ ^3P_2$	3.936	2.20[08]	$3d4f\ ^3G_3$	3.661	2.74[08]
$3d4f\ ^1P_1$	3.637	5.03[14]	$3d4f\ ^3D_2$	3.687	1.98[08]	$3d4f\ ^3F_3$	3.510	2.48[08]
$3p4s\ ^1P_1$	3.489	8.64[14]	$3d4f\ ^1D_2$	3.671	7.13[09]	$3d4f\ ^1F_3$	3.497	8.23[07]
$3p4s\ ^3P_1$	3.300	1.86[13]	$3d4f\ ^3F_2$	3.517	4.37[08]	$3p4d\ ^3F_3$	3.300	5.26[08]
$3p4d\ ^3P_1$	3.249	2.68[14]	$3p4s\ ^3P_2$	3.505	1.30[09]	$3p4d\ ^1F_3$	3.245	3.73[08]
$3p4d\ ^1P_1$	3.153	1.09[13]	$3p4d\ ^3F_2$	3.296	1.66[06]	$3p4d\ ^3D_3$	2.697	9.93[08]
$3p4d\ ^3D_1$	2.824	7.42[13]	$3p4d\ ^3P_2$	3.249	1.72[09]	$3s4f\ ^3F_3$	2.419	6.79[09]
$3s4p\ ^3P_1$	2.729	9.42[13]	$3p4d\ ^3D_2$	2.732	4.67[07]	$3s4f\ ^1F_3$	2.410	3.61[09]
$3s4p\ ^1P_1$	2.655	4.22[13]	$3p4d\ ^1D_2$	2.699	3.38[08]			
			$3s4p\ ^3P_2$	2.656	1.92[08]			
			$3s4f\ ^3F_2$	2.420	2.81[06]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=89$ , even-parity states								
$3d4s\ ^3D_1$	4.671	2.14[05]	$3d4s\ ^3D_2$	4.969	2.36[10]	$3d4s\ ^3D_3$	4.974	9.22[04]
$3d4d\ ^3S_1$	4.007	7.37[08]	$3d4s\ ^1D_2$	4.668	1.80[10]	$3d4d\ ^3G_3$	3.993	1.41[04]
$3d4d\ ^1P_1$	3.932	4.35[08]	$3d4d\ ^3P_2$	3.997	2.51[10]	$3d4d\ ^3D_3$	3.923	1.08[06]
$3d4d\ ^3D_1$	3.803	1.07[07]	$3d4d\ ^3D_2$	3.920	1.05[11]	$3d4d\ ^3F_3$	3.802	1.95[04]
$3d4d\ ^3P_1$	3.773	3.84[09]	$3d4d\ ^3F_2$	3.794	9.58[10]	$3d4d\ ^1F_3$	3.730	8.79[03]
$3p4p\ ^3D_1$	3.739	5.57[08]	$3d4d\ ^1D_2$	3.771	7.35[10]	$3p4p\ ^3D_3$	3.484	1.54[06]
$3p4p\ ^3S_1$	3.483	2.58[08]	$3p4p\ ^3D_2$	3.732	3.61[10]	$3p4f\ ^3D_3$	3.081	2.45[04]
$3p4p\ ^1P_1$	3.091	2.40[07]	$3p4p\ ^1D_2$	3.477	1.19[11]	$3p4f\ ^3G_3$	3.071	1.76[07]
$3p4p\ ^3P_1$	3.050	4.97[07]	$3p4p\ ^3P_2$	3.085	6.81[09]	$3p4f\ ^3F_3$	2.574	1.99[07]
$3p4f\ ^3D_1$	2.916	1.52[06]	$3p4f\ ^3D_2$	3.064	2.24[12]	$3s4d\ ^3D_3$	2.518	1.15[07]
$3s4s\ ^3S_1$	2.854	5.16[09]	$3p4f\ ^1D_2$	2.855	1.18[11]			
$3s4d\ ^3D_1$	2.548	1.51[09]	$3p4f\ ^3F_2$	2.579	2.01[12]			
			$3s4d\ ^3D_2$	2.547	3.36[11]			
			$3s4d\ ^1D_2$	2.518	7.47[11]			

level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=90$ , odd-parity states								
$3d4p\ ^3P_1$	4.318	2.28[13]	$3d4p\ ^3F_2$	4.598	3.34[07]	$3d4p\ ^3F_3$	4.596	2.48[07]
$3d4p\ ^3D_1$	4.145	3.55[13]	$3d4p\ ^3P_2$	4.325	1.95[06]	$3d4p\ ^1F_3$	4.141	3.57[07]
$3d4p\ ^1P_1$	3.924	2.15[12]	$3d4p\ ^1D_2$	4.147	1.23[08]	$3d4p\ ^3D_3$	3.923	6.77[07]
$3d4f\ ^3P_1$	3.831	6.25[13]	$3d4p\ ^3D_2$	3.920	6.51[05]	$3d4f\ ^3D_3$	3.581	2.02[08]
$3d4f\ ^3D_1$	3.593	1.35[11]	$3d4f\ ^3P_2$	3.836	2.46[08]	$3d4f\ ^3G_3$	3.560	3.12[08]
$3d4f\ ^1P_1$	3.536	5.44[14]	$3d4f\ ^3D_2$	3.585	2.00[08]	$3d4f\ ^3F_3$	3.410	2.77[08]
$3p4s\ ^1P_1$	3.390	9.09[14]	$3d4f\ ^1D_2$	3.569	8.01[09]	$3d4f\ ^1F_3$	3.396	9.57[07]
$3p4s\ ^3P_1$	3.210	2.04[13]	$3d4f\ ^3F_2$	3.416	5.09[08]	$3p4d\ ^3F_3$	3.210	5.86[08]
$3p4d\ ^3P_1$	3.159	2.84[14]	$3p4s\ ^3P_2$	3.404	1.45[09]	$3p4d\ ^1F_3$	3.156	4.20[08]
$3p4d\ ^1P_1$	3.053	1.22[13]	$3p4d\ ^3F_2$	3.206	1.70[06]	$3p4d\ ^3D_3$	2.609	1.13[09]
$3p4d\ ^3D_1$	2.738	8.17[13]	$3p4d\ ^3P_2$	3.159	1.94[09]	$3s4f\ ^3F_3$	2.344	7.76[09]
$3s4p\ ^3P_1$	2.641	1.04[14]	$3p4d\ ^3D_2$	2.644	5.26[07]	$3s4f\ ^1F_3$	2.335	4.20[09]
$3s4p\ ^1P_1$	2.570	4.35[13]	$3p4d\ ^1D_2$	2.611	3.70[08]			
			$3s4p\ ^3P_2$	2.571	2.11[08]			
			$3s4f\ ^3F_2$	2.345	2.02[05]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=90$ , even-parity states								
$3d4s\ ^3D_1$	4.543	2.42[05]	$3d4s\ ^3D_2$	4.842	2.58[10]	$3d4s\ ^3D_3$	4.847	1.06[05]
$3d4d\ ^3S_1$	3.896	8.60[08]	$3d4s\ ^1D_2$	4.541	1.96[10]	$3d4d\ ^3G_3$	3.882	1.60[04]
$3d4d\ ^1P_1$	3.820	5.05[08]	$3d4d\ ^3P_2$	3.886	2.81[10]	$3d4d\ ^3D_3$	3.812	1.25[06]
$3d4d\ ^3D_1$	3.694	1.10[07]	$3d4d\ ^3D_2$	3.809	1.15[11]	$3d4d\ ^3F_3$	3.692	2.23[04]
$3d4d\ ^3P_1$	3.677	4.56[09]	$3d4d\ ^3F_2$	3.686	1.40[11]	$3d4d\ ^1F_3$	3.620	1.03[04]
$3p4p\ ^3D_1$	3.629	4.85[08]	$3d4d\ ^1D_2$	3.675	4.82[10]	$3p4p\ ^3D_3$	3.387	1.77[06]
$3p4p\ ^3S_1$	3.387	2.96[08]	$3p4p\ ^3D_2$	3.622	3.65[10]	$3p4f\ ^3D_3$	2.998	2.08[04]
$3p4p\ ^1P_1$	3.008	2.28[07]	$3p4p\ ^1D_2$	3.380	1.31[11]	$3p4f\ ^3G_3$	2.987	2.02[07]
$3p4p\ ^3P_1$	2.955	5.52[07]	$3p4p\ ^3P_2$	3.002	1.07[10]	$3p4f\ ^3F_3$	2.491	2.15[07]
$3p4f\ ^3D_1$	2.826	2.61[05]	$3p4f\ ^3D_2$	2.980	2.43[12]	$3s4d\ ^3D_3$	2.438	1.35[07]
$3s4s\ ^3S_1$	2.760	5.93[09]	$3p4f\ ^1D_2$	2.761	1.31[11]			
$3s4d\ ^3D_1$	2.468	3.23[07]	$3p4f\ ^3F_2$	2.497	1.57[12]			
			$3s4d\ ^3D_2$	2.467	3.78[11]			
			$3s4d\ ^1D_2$	2.438	8.35[11]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=91$ , odd-parity states								
$3d4p\ ^3P_1$	4.204	2.44[13]	$3d4p\ ^3F_2$	4.484	3.75[07]	$3d4p\ ^3F_3$	4.482	2.72[07]
$3d4p\ ^3D_1$	4.028	3.77[13]	$3d4p\ ^3P_2$	4.211	2.22[06]	$3d4p\ ^1F_3$	4.024	4.01[07]
$3d4p\ ^1P_1$	3.809	1.95[12]	$3d4p\ ^1D_2$	4.030	1.39[08]	$3d4p\ ^3D_3$	3.808	7.64[07]
$3d4f\ ^3P_1$	3.735	6.66[13]	$3d4p\ ^3D_2$	3.805	1.41[06]	$3d4f\ ^3D_3$	3.484	2.19[08]
$3d4f\ ^3D_1$	3.495	2.06[11]	$3d4f\ ^3P_2$	3.740	2.76[08]	$3d4f\ ^3G_3$	3.463	3.53[08]
$3d4f\ ^1P_1$	3.440	5.88[14]	$3d4f\ ^3D_2$	3.488	2.01[08]	$3d4f\ ^3F_3$	3.313	3.09[08]
$3p4s\ ^1P_1$	3.294	9.50[14]	$3d4f\ ^1D_2$	3.471	8.99[09]	$3d4f\ ^1F_3$	3.300	1.11[08]
$3p4s\ ^3P_1$	3.124	2.20[13]	$3d4f\ ^3F_2$	3.319	5.88[08]	$3p4d\ ^3F_3$	3.123	6.51[08]
$3p4d\ ^3P_1$	3.072	3.00[14]	$3p4s\ ^3P_2$	3.307	1.61[09]	$3p4d\ ^1F_3$	3.069	4.72[08]
$3p4d\ ^1P_1$	2.958	1.37[13]	$3p4d\ ^3F_2$	3.120	1.74[06]	$3p4d\ ^3D_3$	2.525	1.29[09]
$3p4d\ ^3D_1$	2.655	7.90[13]	$3p4d\ ^3P_2$	3.073	2.18[09]	$3s4f\ ^3F_3$	2.271	8.85[09]
$3s4p\ ^3P_1$	2.556	1.10[14]	$3p4d\ ^3D_2$	2.559	5.81[07]	$3s4f\ ^1F_3$	2.262	5.07[09]
$3s4p\ ^1P_1$	2.488	4.49[13]	$3p4d\ ^1D_2$	2.526	4.27[08]			
			$3s4p\ ^3P_2$	2.489	2.30[08]			
			$3s4f\ ^3F_2$	2.273	2.53[04]			

level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=91$ , even-parity states								
$3d4s\ ^3D_1$	4.422	2.86[05]	$3d4s\ ^3D_2$	4.721	2.80[10]	$3d4s\ ^3D_3$	4.725	1.20[05]
$3d4d\ ^3S_1$	3.789	1.00[09]	$3d4s\ ^1D_2$	4.420	2.13[10]	$3d4d\ ^3G_3$	3.776	1.81[04]
$3d4d\ ^1P_1$	3.714	5.88[08]	$3d4d\ ^3P_2$	3.780	3.13[10]	$3d4d\ ^3D_3$	3.705	1.44[06]
$3d4d\ ^3D_1$	3.592	9.52[08]	$3d4d\ ^3D_2$	3.703	1.25[11]	$3d4d\ ^3F_3$	3.586	2.56[04]
$3d4d\ ^3P_1$	3.582	4.35[09]	$3d4d\ ^3F_2$	3.588	2.02[11]	$3d4d\ ^1F_3$	3.515	1.22[04]
$3p4p\ ^3D_1$	3.523	4.78[08]	$3d4d\ ^1D_2$	3.576	3.67[09]	$3p4p\ ^3D_3$	3.294	2.04[06]
$3p4p\ ^3S_1$	3.294	3.43[08]	$3p4p\ ^3D_2$	3.517	3.81[10]	$3p4f\ ^3D_3$	2.918	1.73[04]
$3p4p\ ^1P_1$	2.927	2.64[07]	$3p4p\ ^1D_2$	3.288	1.42[11]	$3p4f\ ^3G_3$	2.907	2.31[07]
$3p4p\ ^3P_1$	2.863	6.36[07]	$3p4p\ ^3P_2$	2.921	1.49[10]	$3p4f\ ^3F_3$	2.412	2.37[07]
$3p4f\ ^3D_1$	2.740	4.61[06]	$3p4f\ ^3D_2$	2.900	2.63[12]	$3s4d\ ^3D_3$	2.362	1.57[07]
$3s4s\ ^3S_1$	2.670	6.84[09]	$3p4f\ ^1D_2$	2.670	1.45[11]			
$3s4d\ ^3D_1$	2.391	1.50[07]	$3p4f\ ^3F_2$	2.418	1.92[12]			
			$3s4d\ ^3D_2$	2.390	4.24[11]			
			$3s4d\ ^1D_2$	2.361	9.17[11]			
level	$\lambda$	$A^{E1}$	level	$\lambda$	$A^{M2}$	level	$\lambda$	$A^{E3}$
Nuclear charge $Z=92$ , odd-parity states								
$3d4p\ ^3P_1$	4.095	2.61[13]	$3d4p\ ^3F_2$	4.375	4.21[07]	$3d4p\ ^3F_3$	4.373	2.98[07]
$3d4p\ ^3D_1$	3.917	4.00[13]	$3d4p\ ^3P_2$	4.101	2.54[06]	$3d4p\ ^1F_3$	3.913	4.49[07]
$3d4p\ ^1P_1$	3.699	1.50[12]	$3d4p\ ^1D_2$	3.919	1.56[08]	$3d4p\ ^3D_3$	3.698	8.61[07]
$3d4f\ ^3P_1$	3.644	7.11[13]	$3d4p\ ^3D_2$	3.695	3.46[06]	$3d4f\ ^3D_3$	3.391	2.39[08]
$3d4f\ ^3D_1$	3.401	3.02[11]	$3d4f\ ^3P_2$	3.648	3.06[08]	$3d4f\ ^3G_3$	3.369	3.99[08]
$3d4f\ ^1P_1$	3.347	6.33[14]	$3d4f\ ^3D_2$	3.394	2.03[08]	$3d4f\ ^3F_3$	3.221	3.45[08]
$3p4s\ ^1P_1$	3.203	9.98[14]	$3d4f\ ^1D_2$	3.378	1.01[10]	$3d4f\ ^1F_3$	3.207	1.28[08]
$3p4s\ ^3P_1$	3.041	2.38[13]	$3d4f\ ^3F_2$	3.227	6.77[08]	$3p4d\ ^3F_3$	3.040	7.23[08]
$3p4d\ ^3P_1$	2.990	3.19[14]	$3p4s\ ^3P_2$	3.214	1.80[09]	$3p4d\ ^1F_3$	2.987	5.29[08]
$3p4d\ ^1P_1$	2.866	1.38[13]	$3p4d\ ^3F_2$	3.037	1.78[06]	$3p4d\ ^3D_3$	2.443	1.46[09]
$3p4d\ ^3D_1$	2.576	8.37[13]	$3p4d\ ^3P_2$	2.990	2.44[09]	$3s4f\ ^3F_3$	2.202	1.02[10]
$3s4p\ ^3P_1$	2.475	1.16[14]	$3p4d\ ^3D_2$	2.477	6.43[07]	$3s4f\ ^1F_3$	2.193	5.83[09]
$3s4p\ ^1P_1$	2.410	3.54[13]	$3p4d\ ^1D_2$	2.445	4.78[08]			
			$3s4p\ ^3P_2$	2.410	2.49[08]			
			$3s4f\ ^3F_2$	2.203	4.68[05]			
level	$\lambda$	$A^{M1}$	level	$\lambda$	$A^{E2}$	level	$\lambda$	$A^{M3}$
Nuclear charge $Z=92$ , even-parity states								
$3d4s\ ^3D_1$	4.306	3.33[05]	$3d4s\ ^3D_2$	4.605	3.03[10]	$3d4s\ ^3D_3$	4.609	1.37[05]
$3d4d\ ^3S_1$	3.687	1.16[09]	$3d4s\ ^1D_2$	4.304	2.31[10]	$3d4d\ ^3G_3$	3.674	2.04[04]
$3d4d\ ^1P_1$	3.612	6.84[08]	$3d4d\ ^3P_2$	3.678	3.48[10]	$3d4d\ ^3D_3$	3.603	1.66[06]
$3d4d\ ^3D_1$	3.501	4.58[09]	$3d4d\ ^3D_2$	3.601	1.36[11]	$3d4d\ ^3F_3$	3.485	2.93[04]
$3d4d\ ^3P_1$	3.484	1.50[09]	$3d4d\ ^3F_2$	3.500	1.81[11]	$3d4d\ ^1F_3$	3.414	1.43[04]
$3p4p\ ^3D_1$	3.422	4.96[08]	$3d4d\ ^1D_2$	3.476	4.27[10]	$3p4p\ ^3D_3$	3.205	2.35[06]
$3p4p\ ^3S_1$	3.204	3.96[08]	$3p4p\ ^3D_2$	3.416	4.04[10]	$3p4f\ ^3D_3$	2.841	1.39[04]
$3p4p\ ^1P_1$	2.850	3.06[07]	$3p4p\ ^1D_2$	3.199	1.55[11]	$3p4f\ ^3G_3$	2.830	2.65[07]
$3p4p\ ^3P_1$	2.775	7.32[07]	$3p4p\ ^3P_2$	2.844	1.99[10]	$3p4f\ ^3F_3$	2.336	2.64[07]
$3p4f\ ^3D_1$	2.657	1.44[07]	$3p4f\ ^3D_2$	2.824	2.85[12]	$3s4d\ ^3D_3$	2.288	1.83[07]
$3s4s\ ^3S_1$	2.583	7.83[09]	$3p4f\ ^1D_2$	2.583	1.59[11]			
$3s4d\ ^3D_1$	2.317	1.13[07]	$3p4f\ ^3F_2$	2.342	2.13[12]			
			$3s4d\ ^3D_2$	2.316	4.65[11]			
			$3s4d\ ^1D_2$	2.287	1.08[12]			

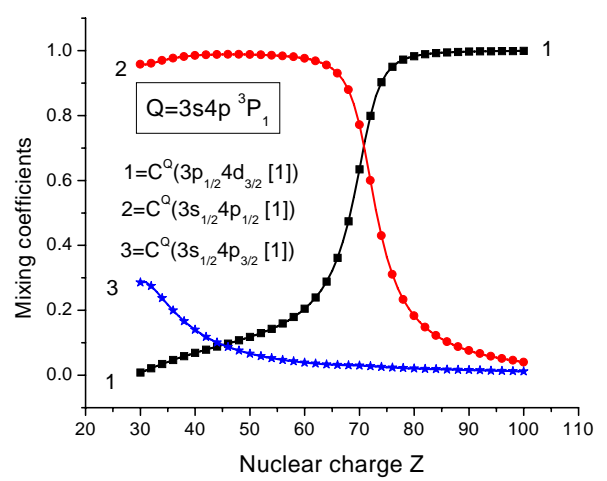
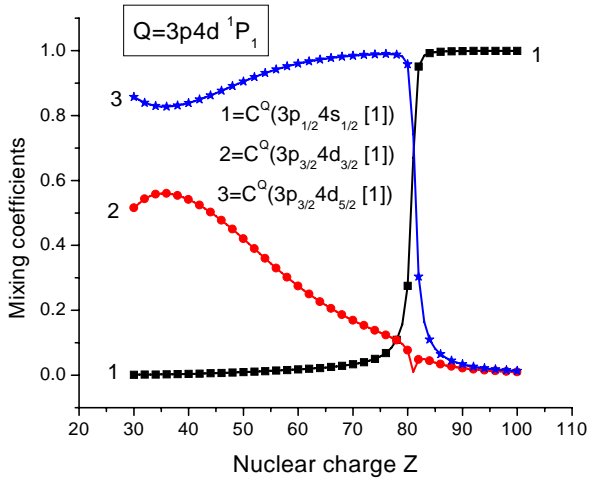
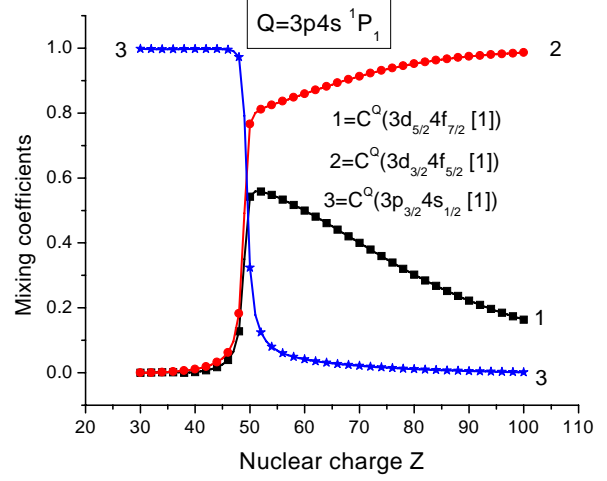
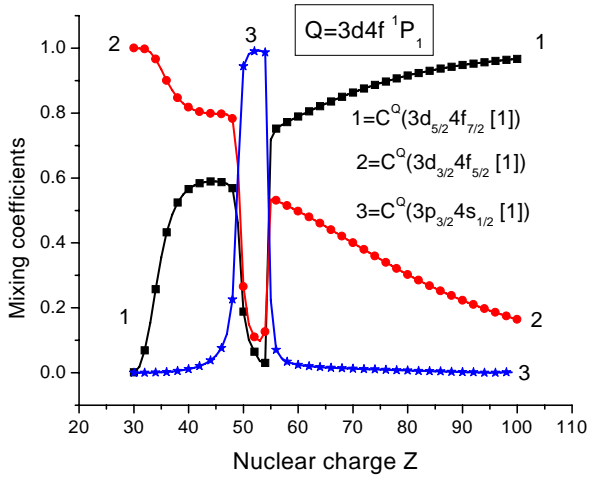
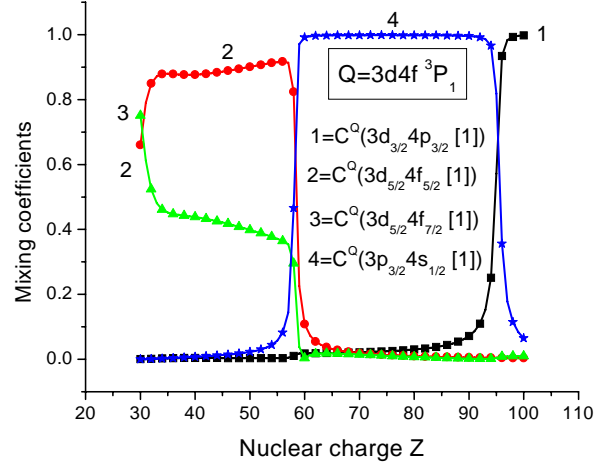
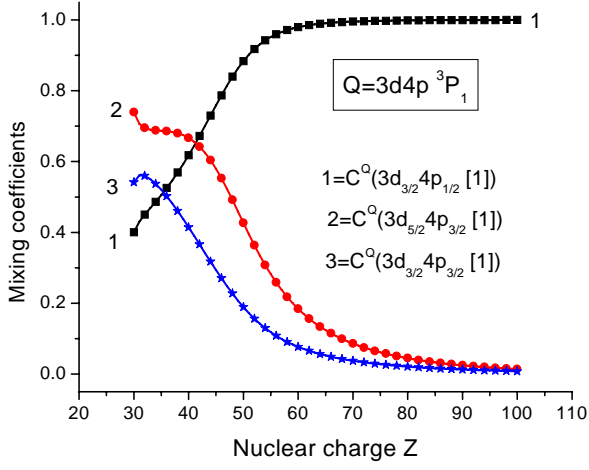


FIG. 1: Mixing coefficients for odd-parity states with  $J=1$  as functions of  $Z$

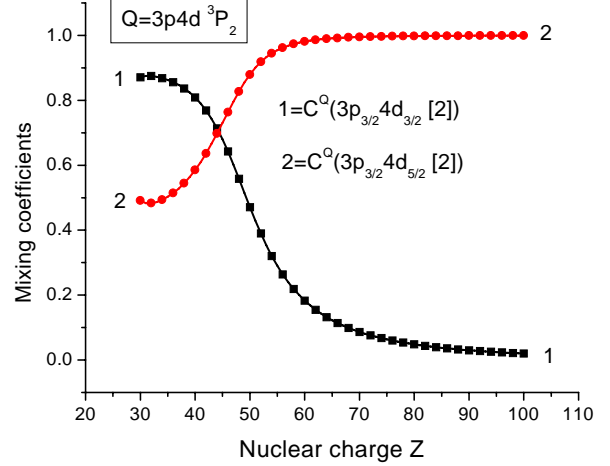
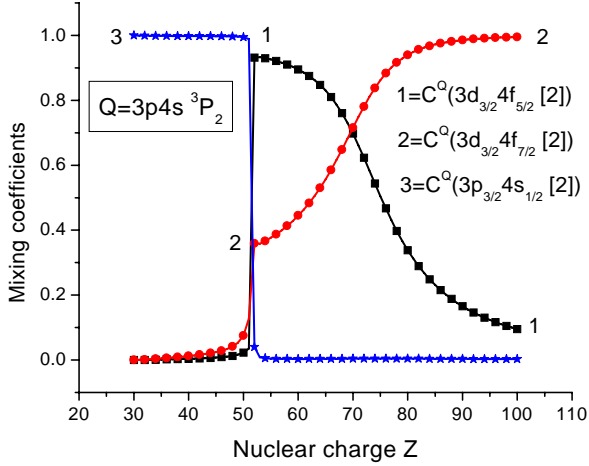
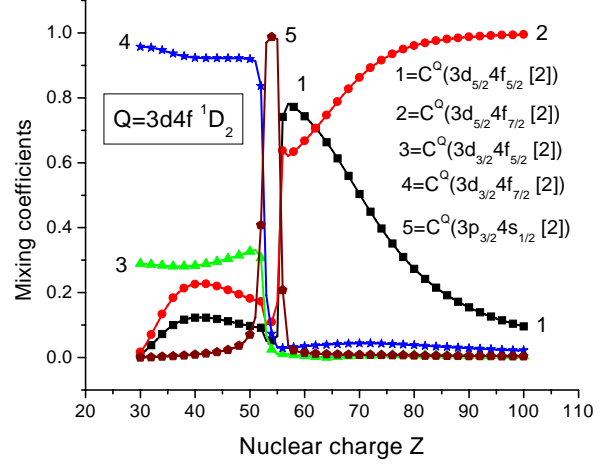
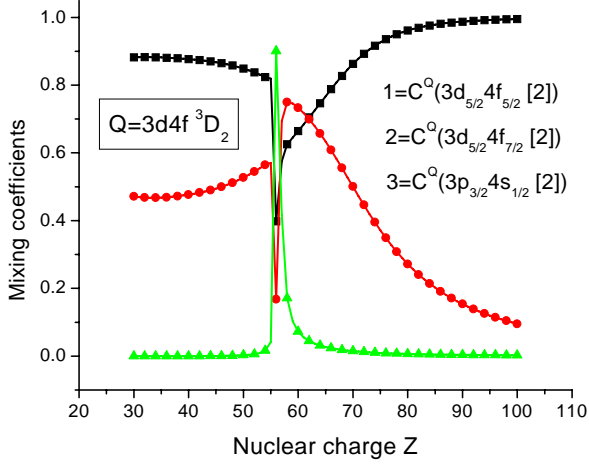
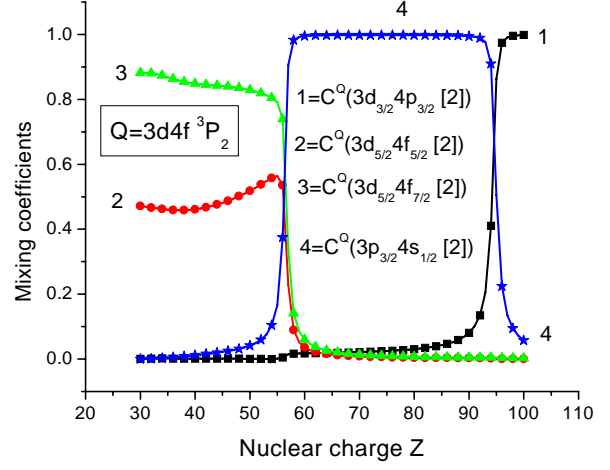
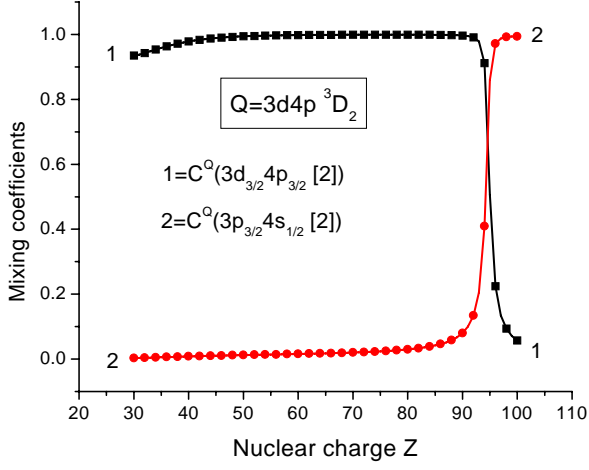


FIG. 2: Mixing coefficients for odd-parity states with  $J=2$  as functions of  $Z$

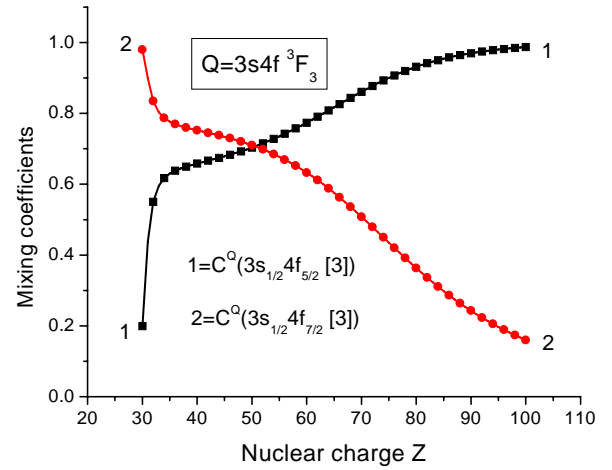
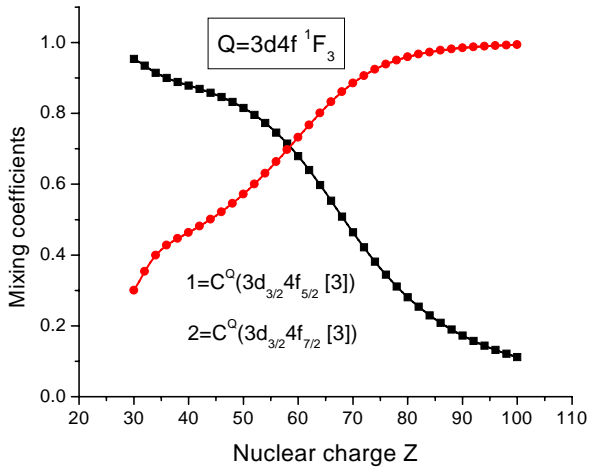
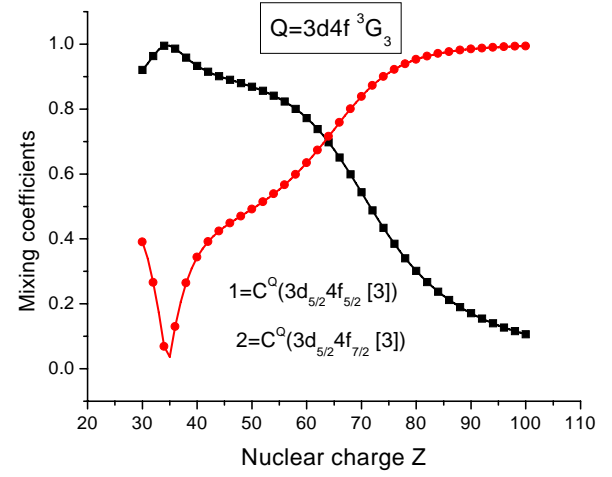
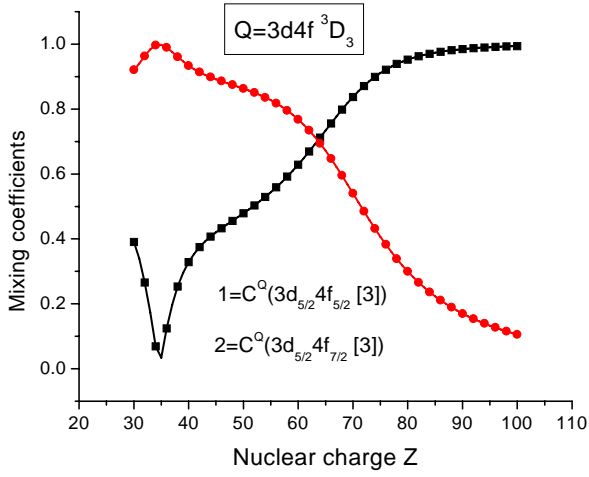
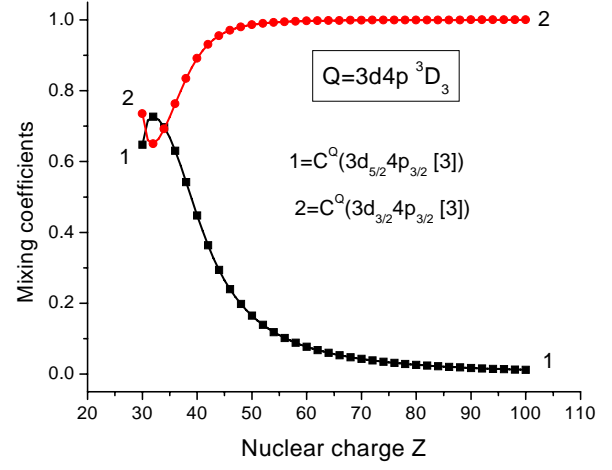
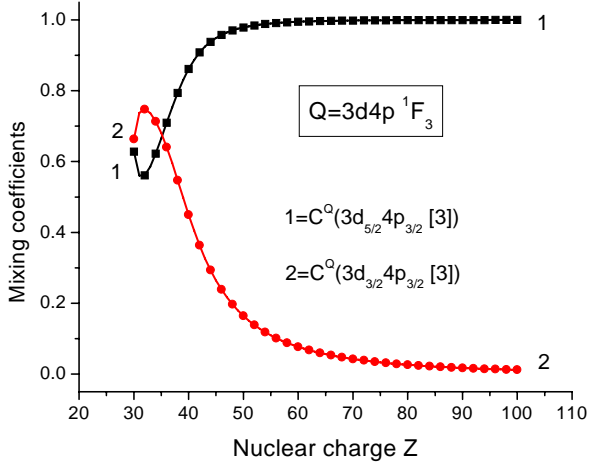


FIG. 3: Mixing coefficients for odd-parity states with  $J=3$  as functions of  $Z$



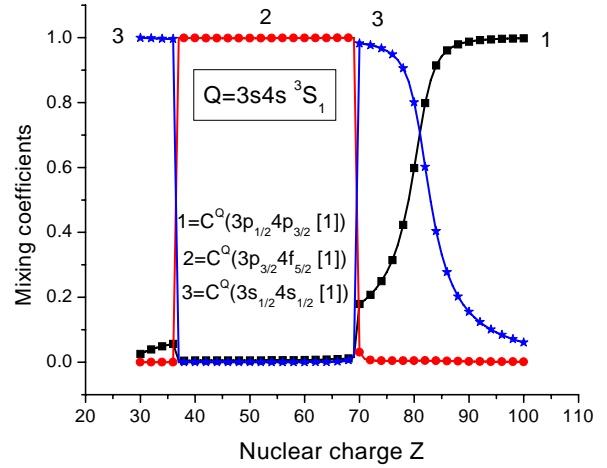
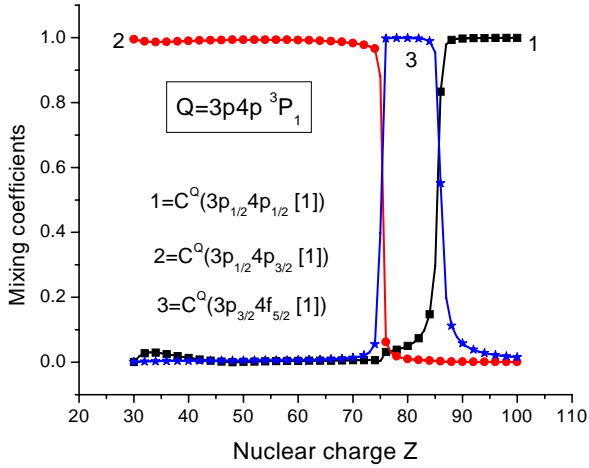
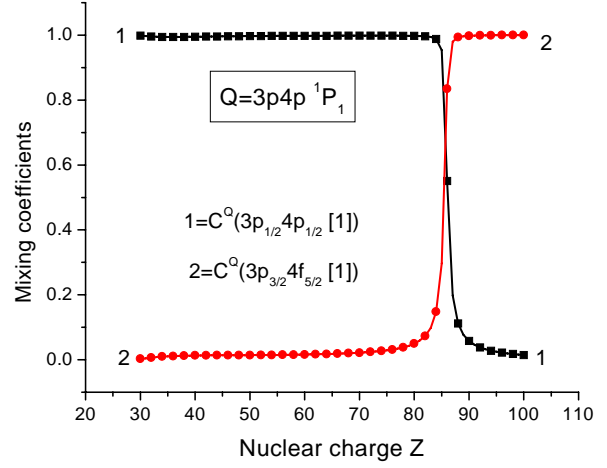
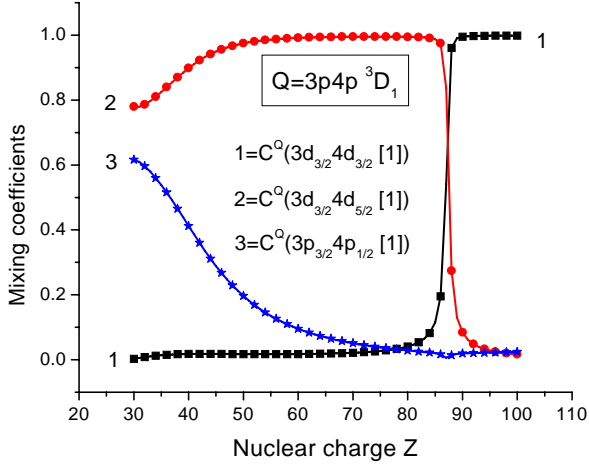
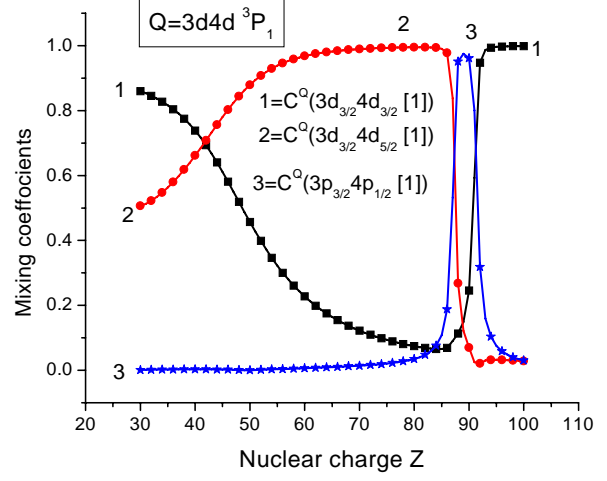
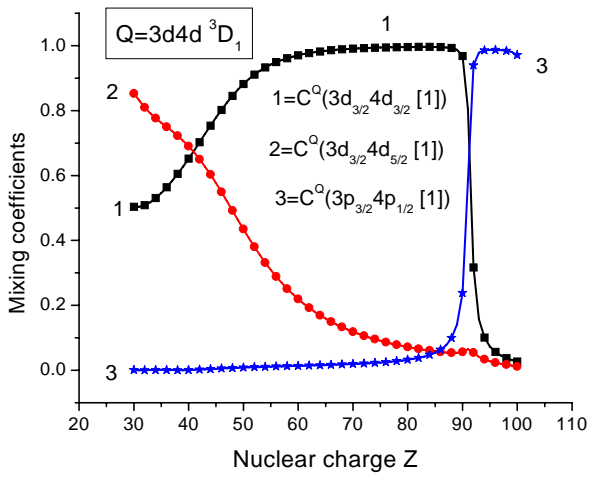


FIG. 4: Mixing coefficients for even-parity states with  $J=1$  as functions of  $Z$

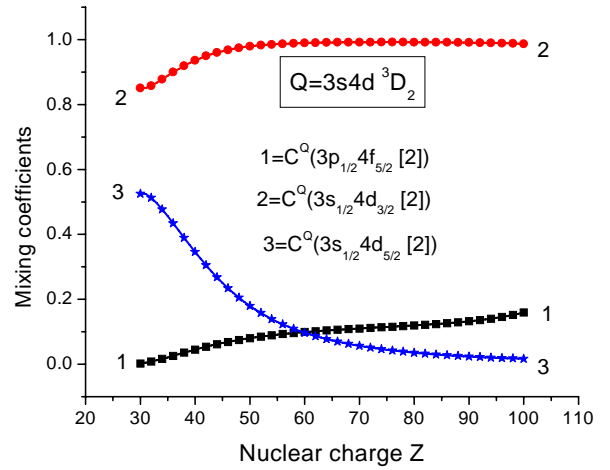
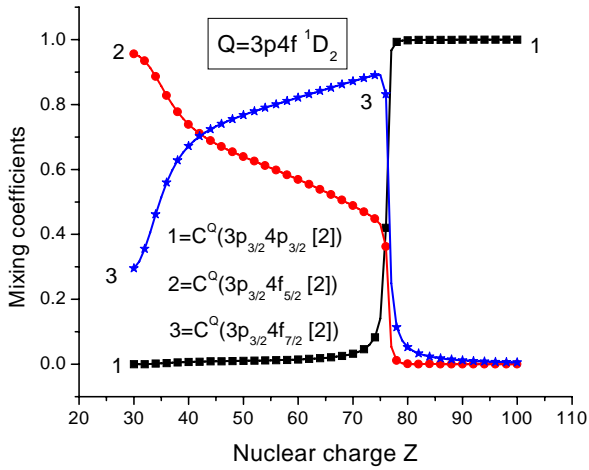
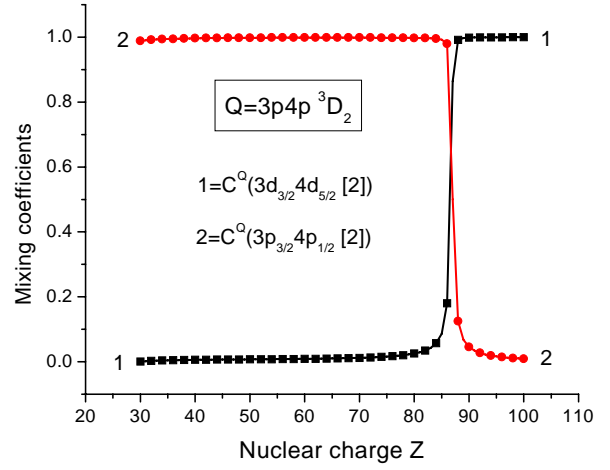
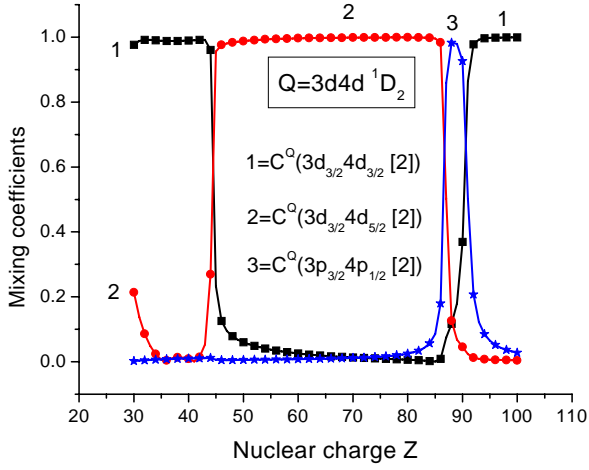
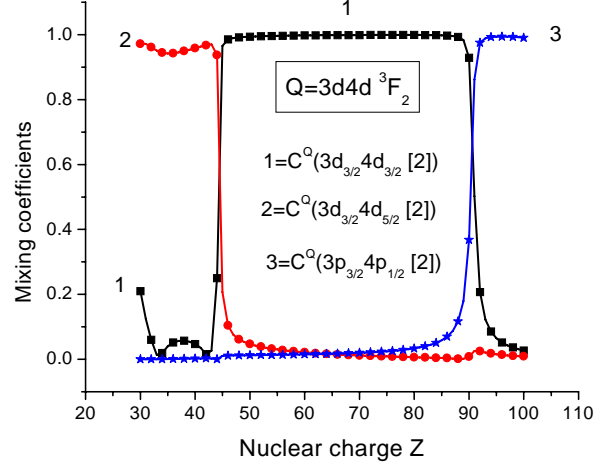
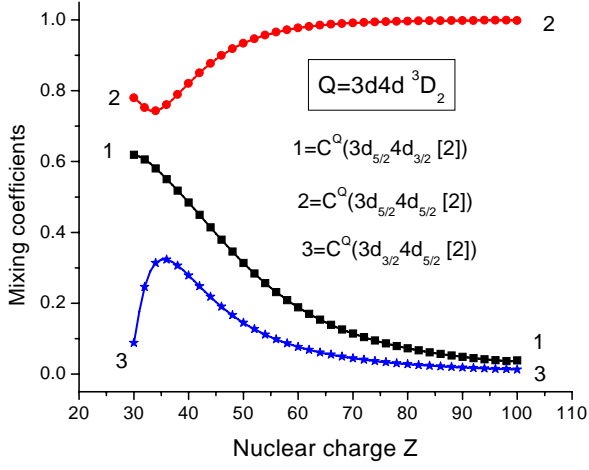


FIG. 5: Mixing coefficients for even-parity states with  $J=2$  as functions of  $Z$

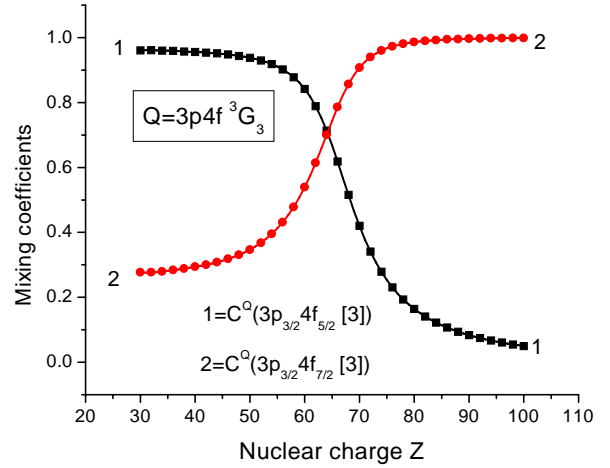
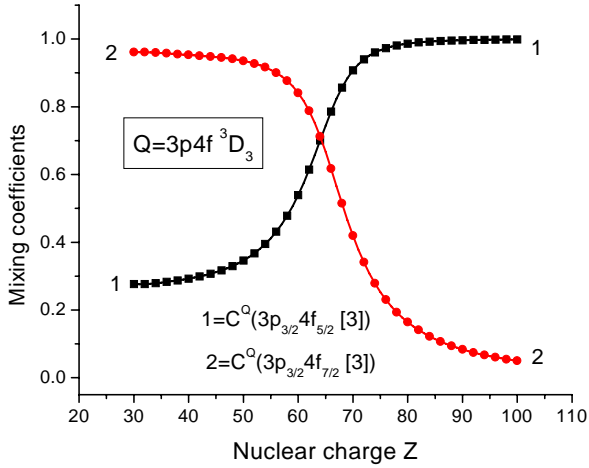
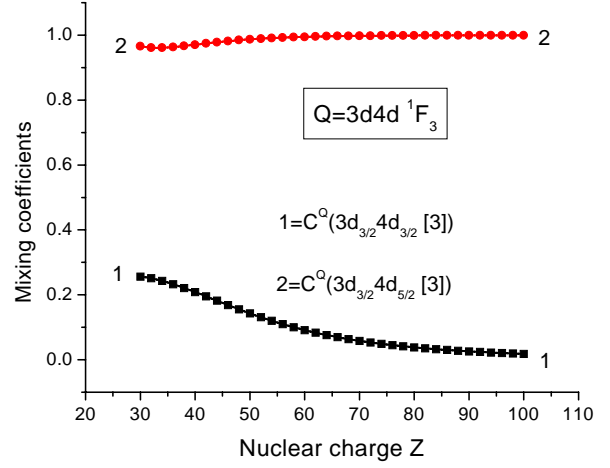
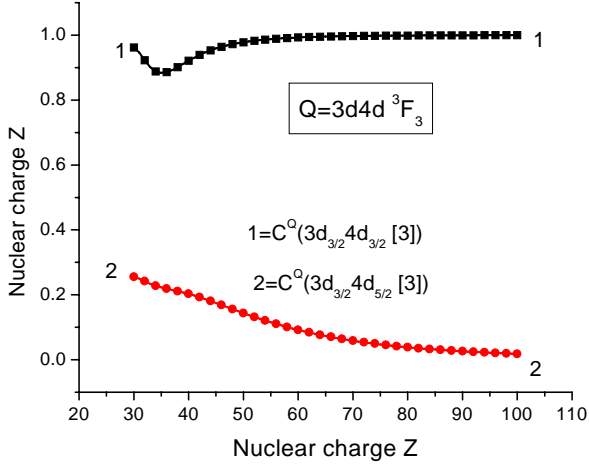
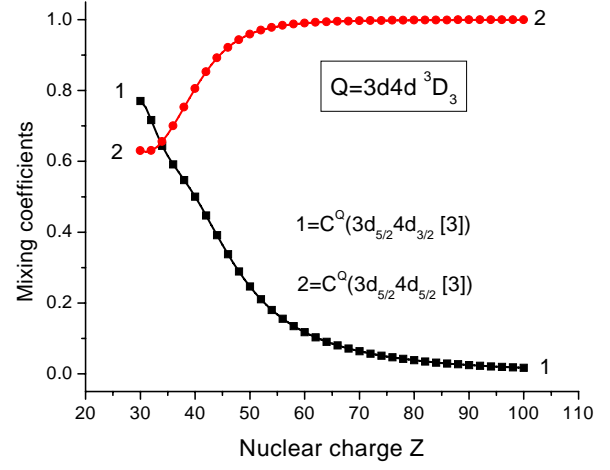
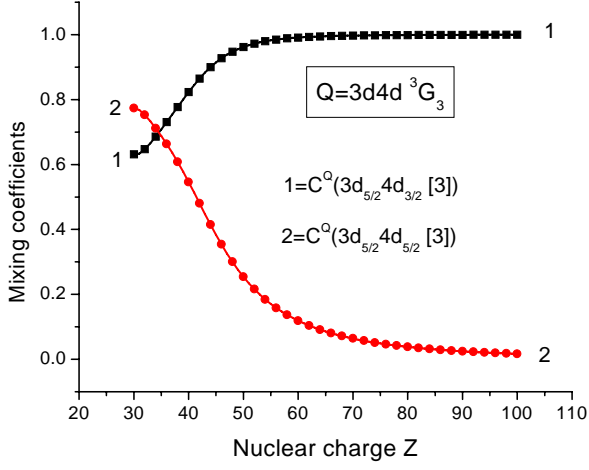


FIG. 6: Mixing coefficients for even-parity states with  $J=3$  as functions of  $Z$

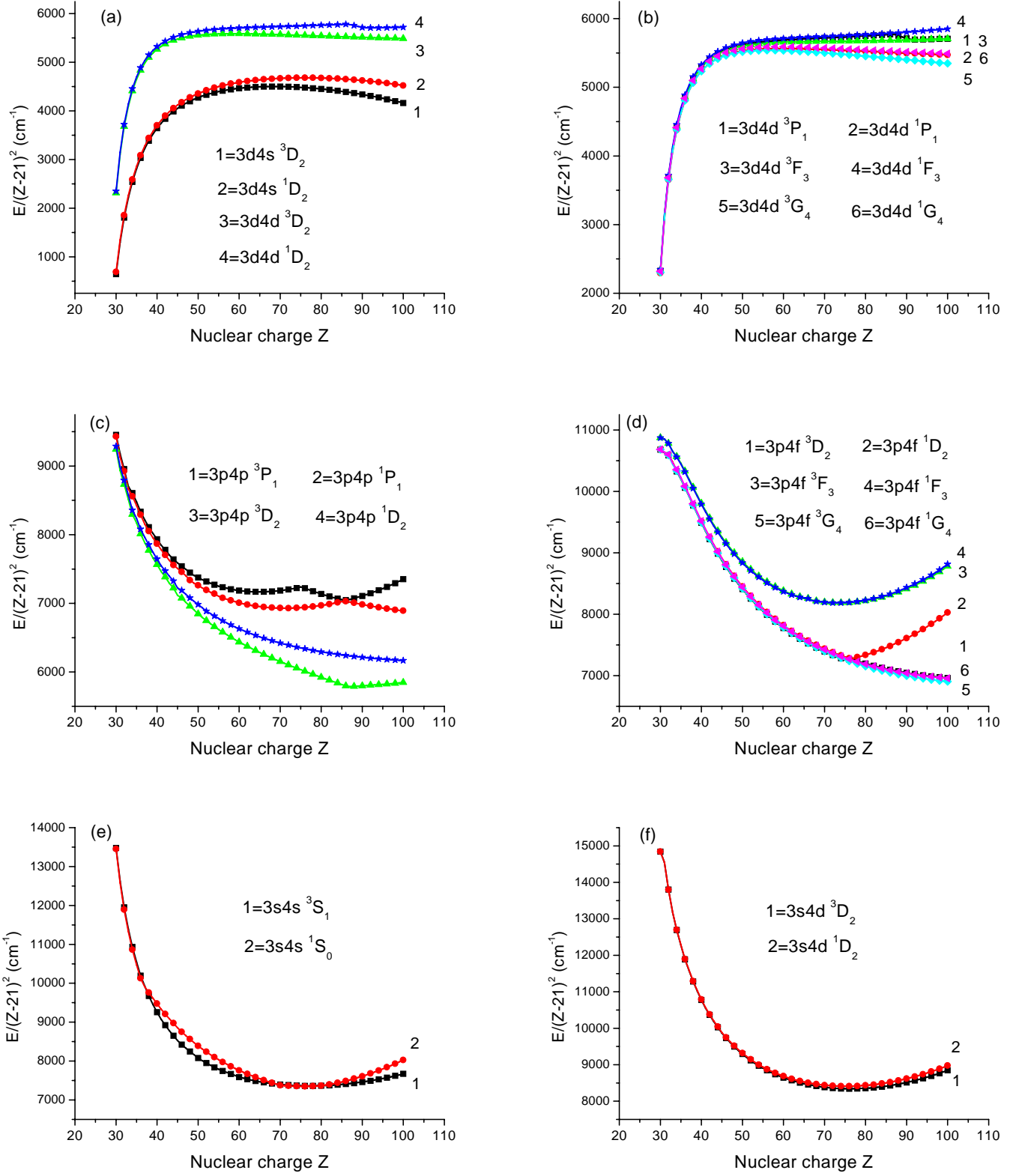


FIG. 7: Energies ( $E/(Z - 21)^2$ ) in cm<sup>-1</sup> for even-parity states as function of  $Z$

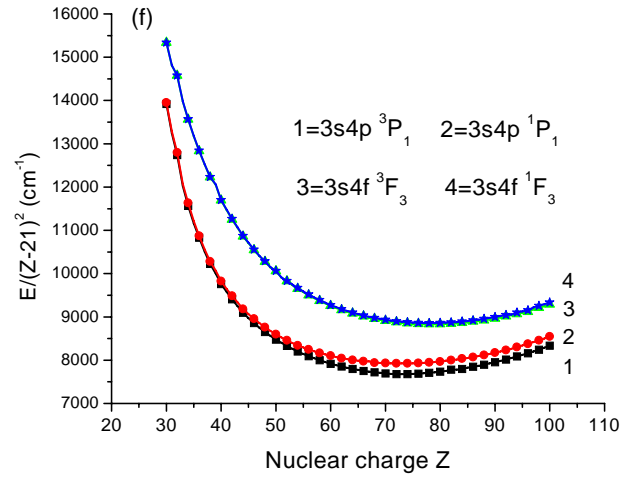
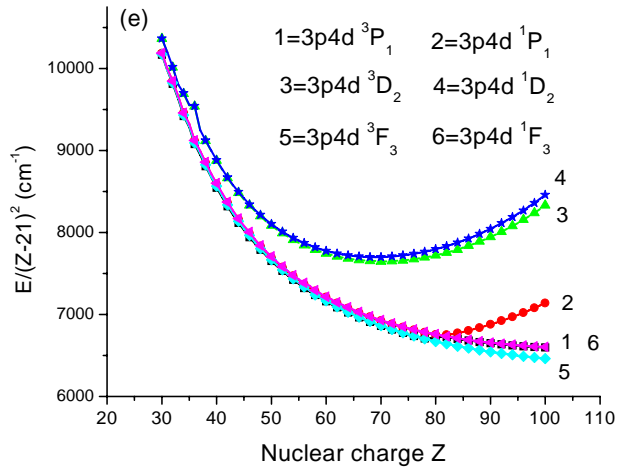
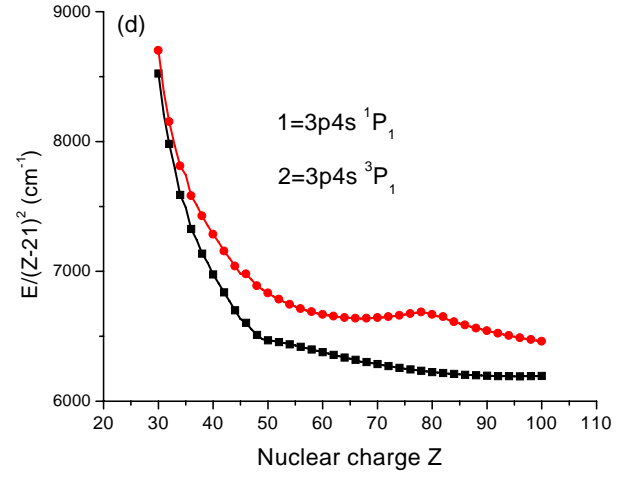
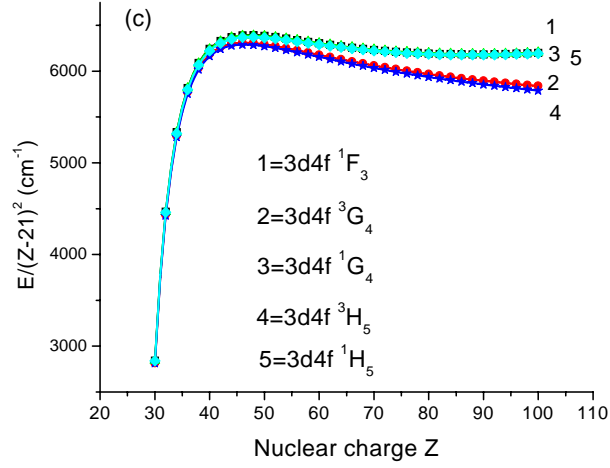
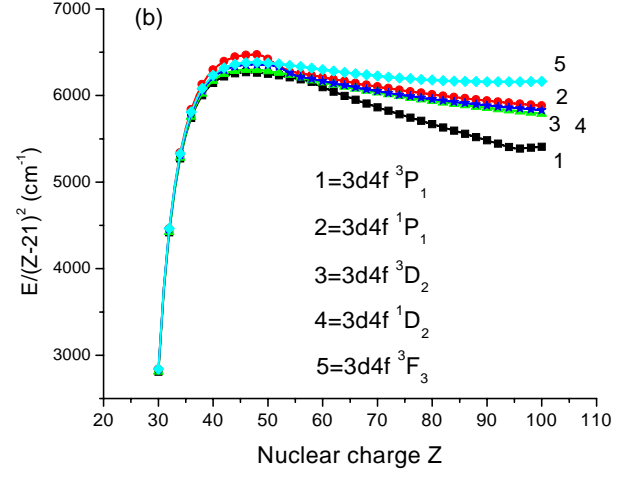
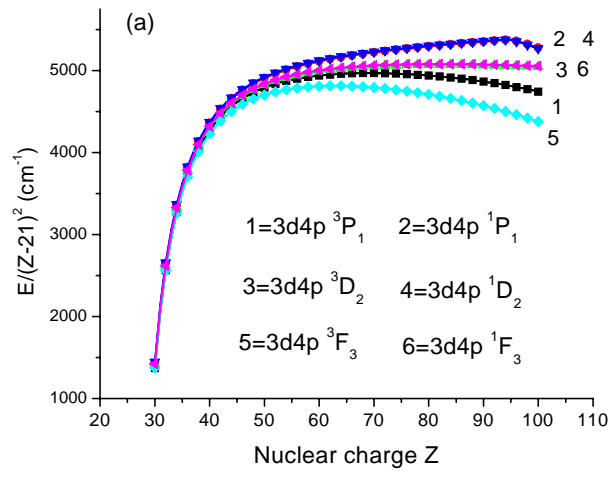


FIG. 8: Energies  $(E/(Z-21)^2)$  in cm<sup>-1</sup> for odd-parity states as function of  $Z$

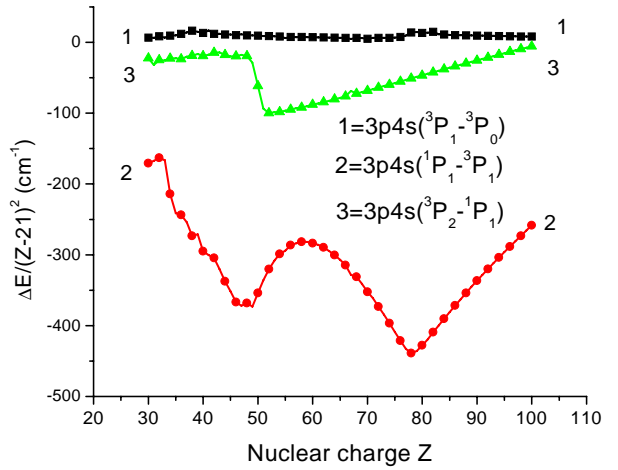
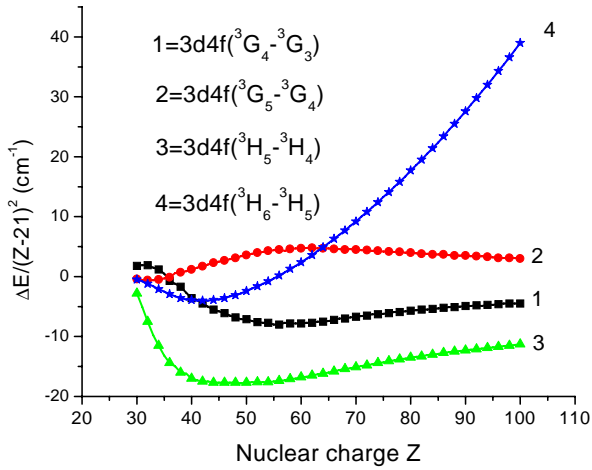
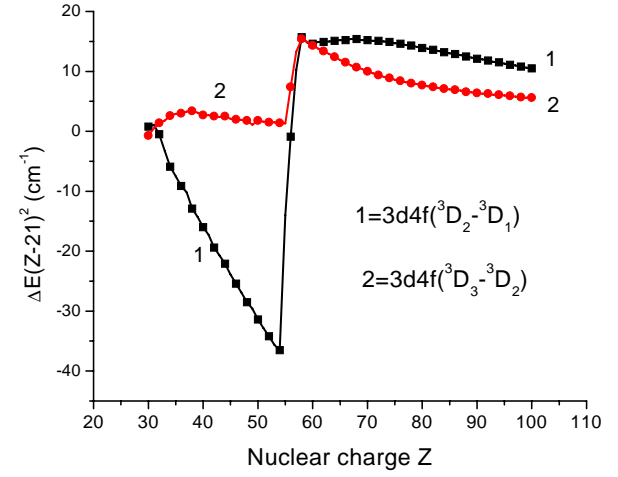
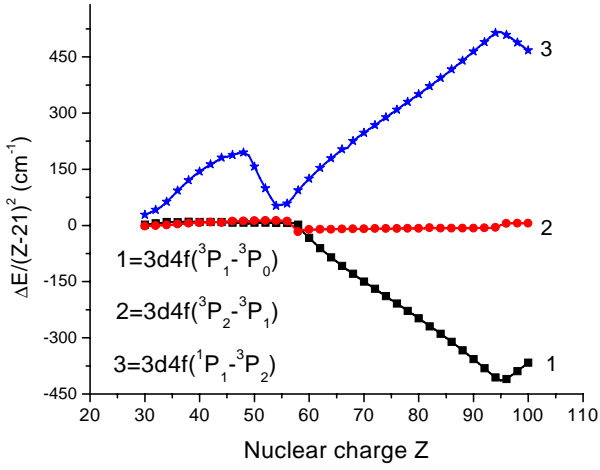
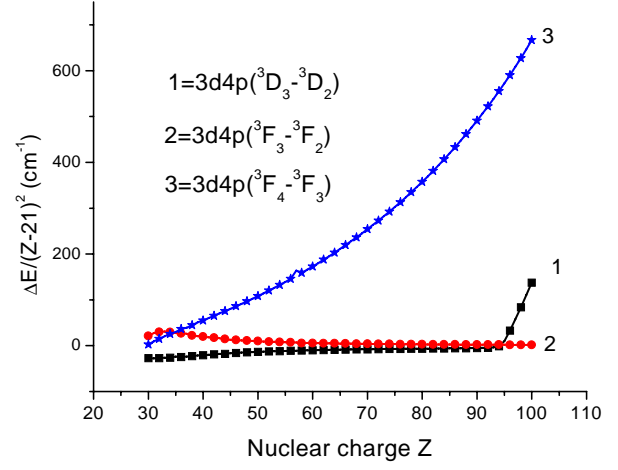
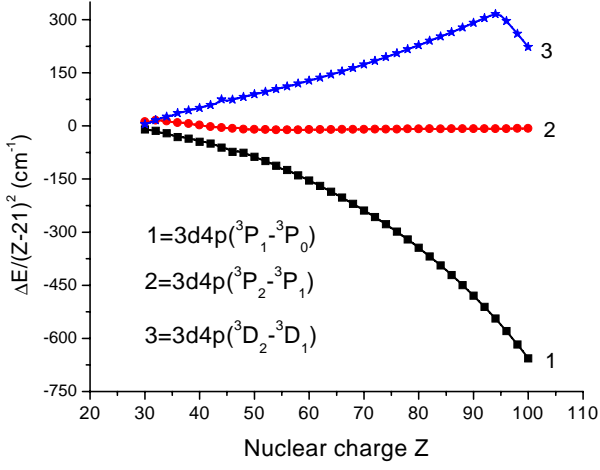


FIG. 9: Energy splitting ( $\Delta E/(Z-21)^2$ ) in cm<sup>-1</sup> for terms of odd-parity states as function of  $Z$

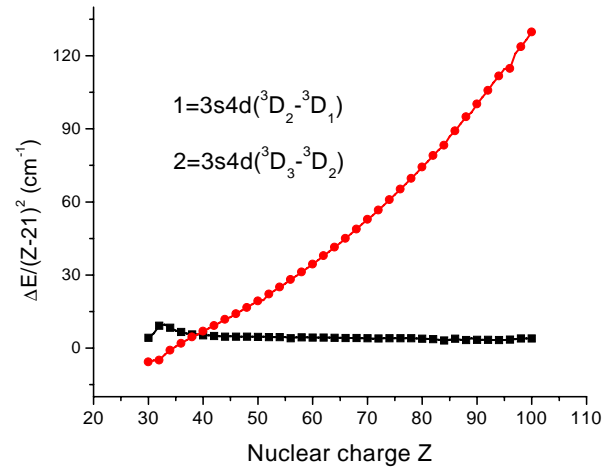
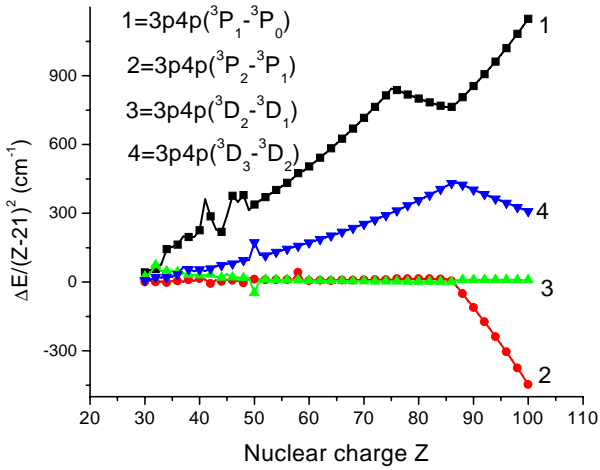
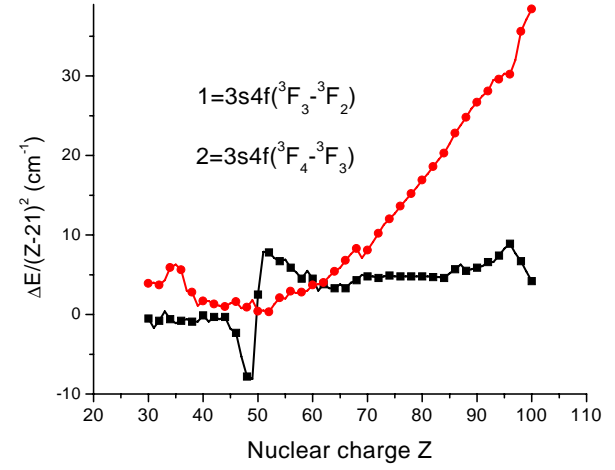
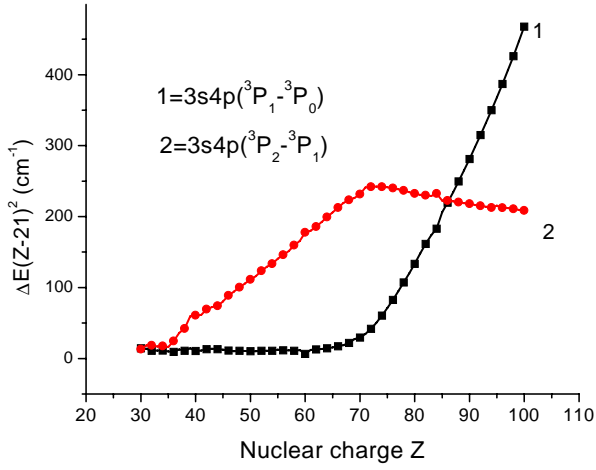
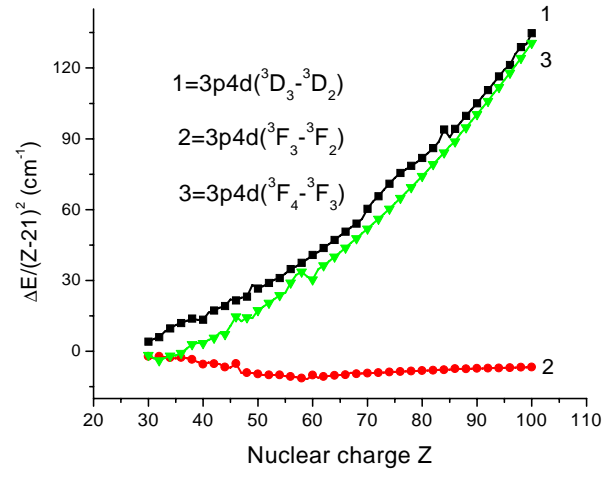
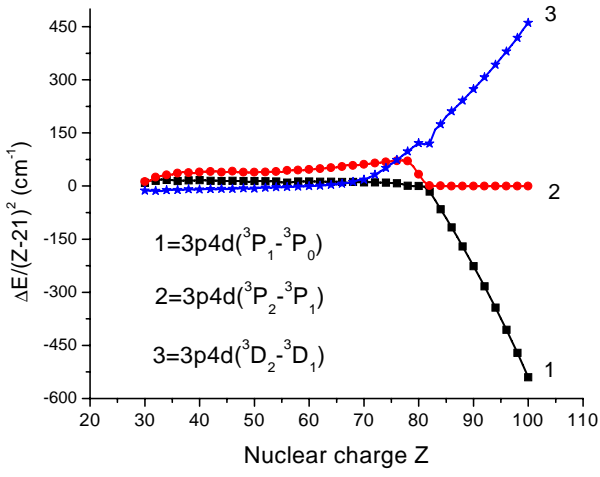


FIG. 10: Energy splitting ( $\Delta E/(Z-21)^2$ ) in cm<sup>-1</sup> for terms of odd- and even-parity states as function of  $Z$

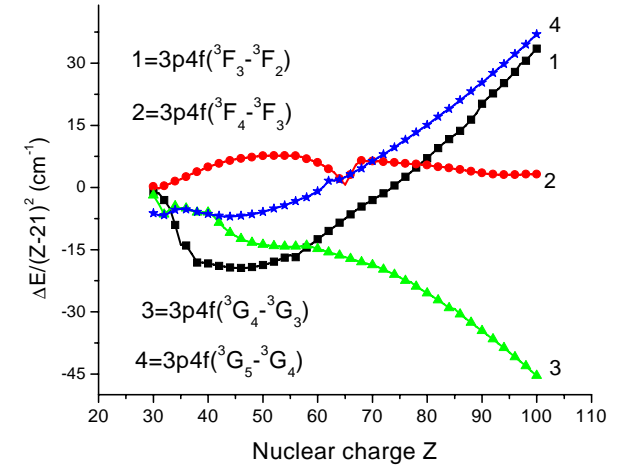
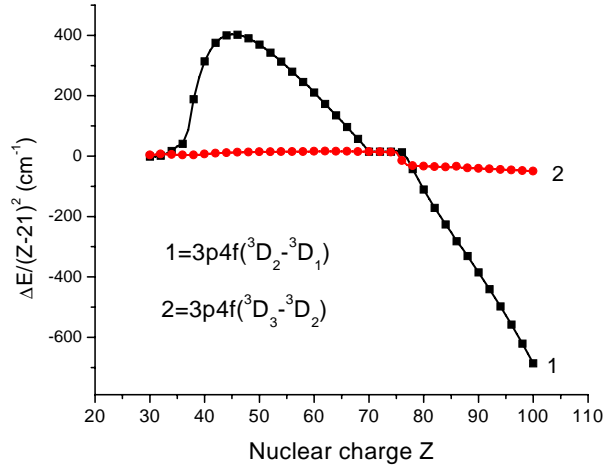
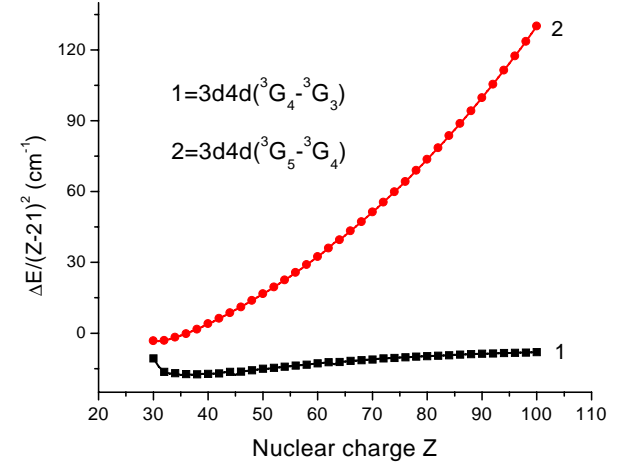
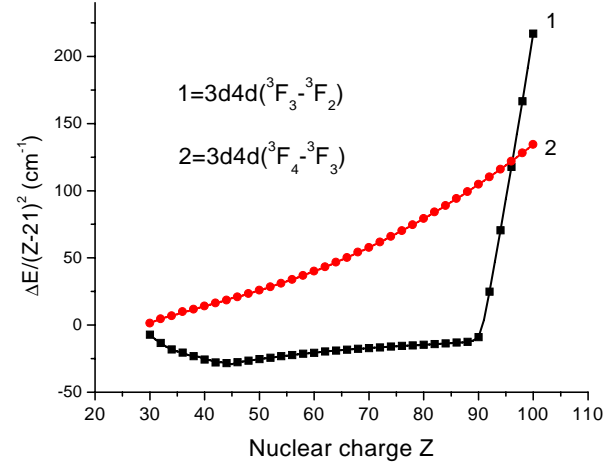
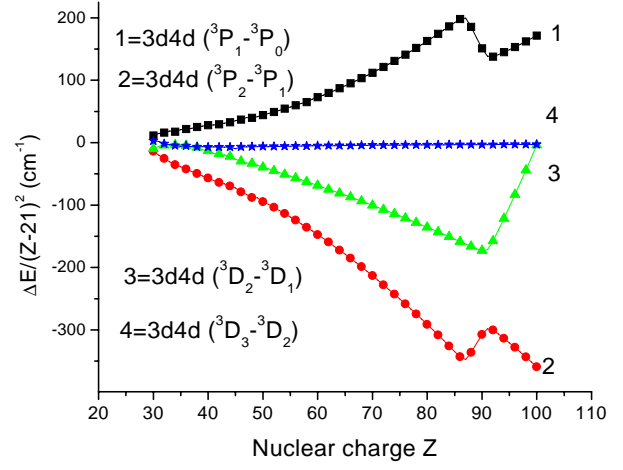
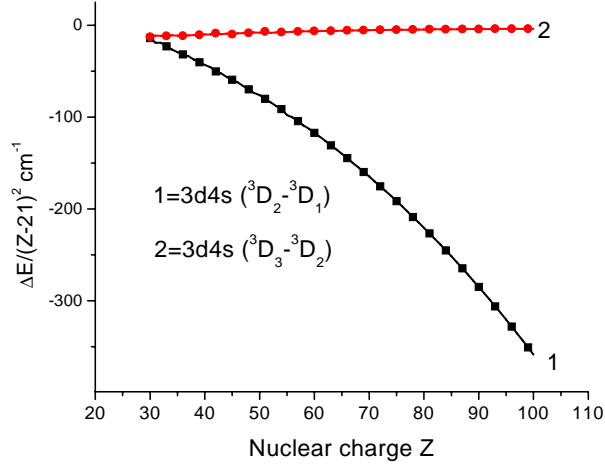


FIG. 11: Energy splitting ( $\Delta E/(Z - 21)^2$ ) in cm<sup>-1</sup> for terms of even-parity states as function of  $Z$



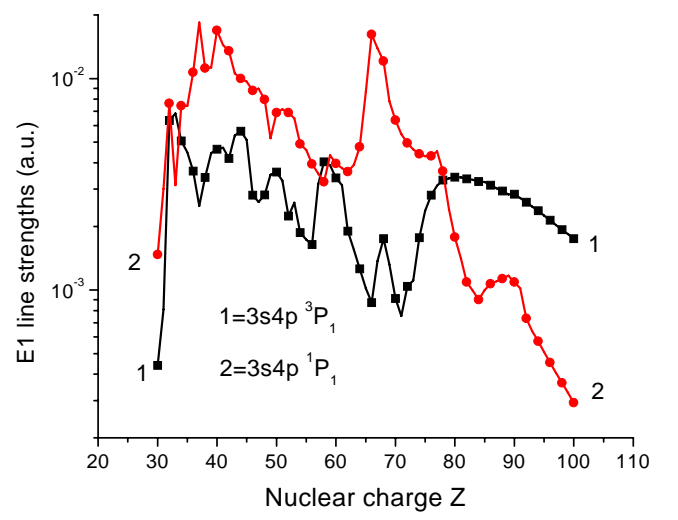
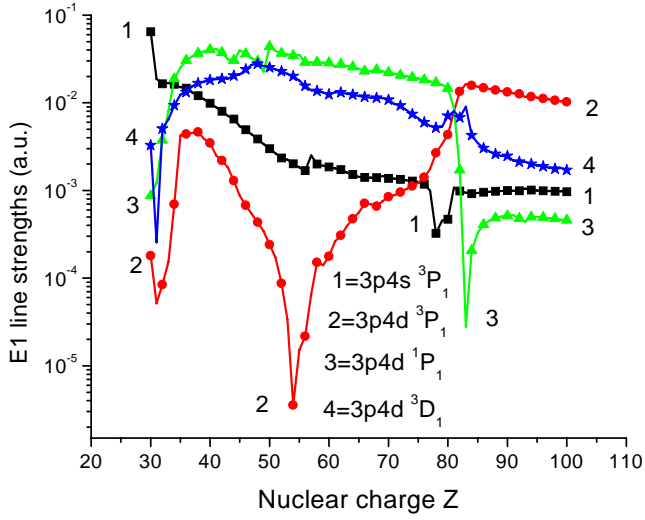
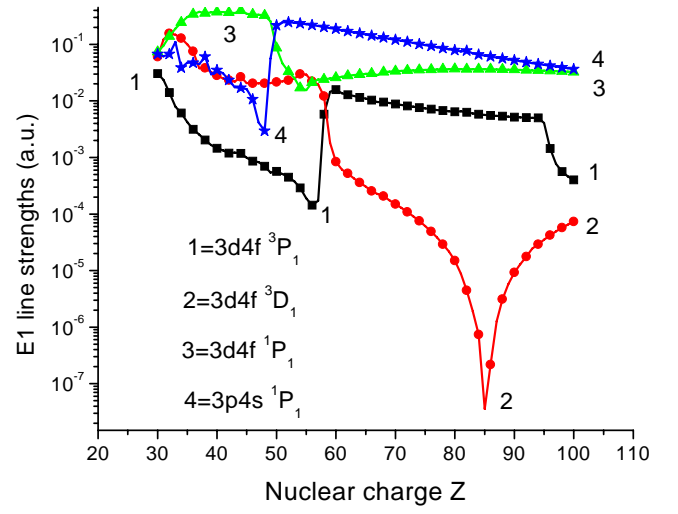
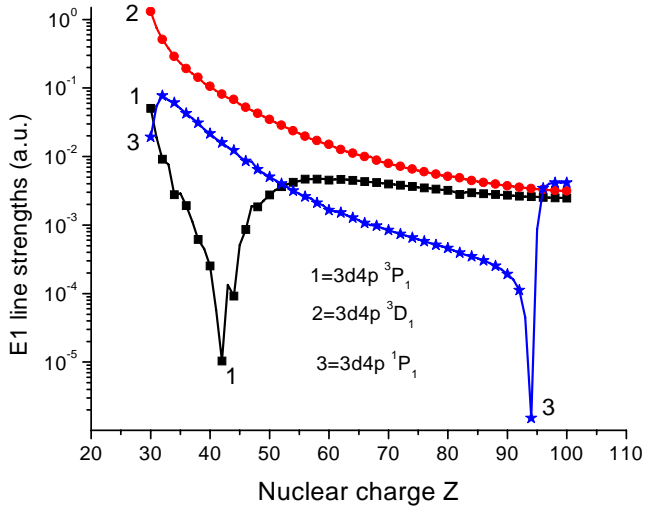


FIG. 12: E1 line strengths between odd-parity states with  $J = 1$  and the ground state as function of  $Z$

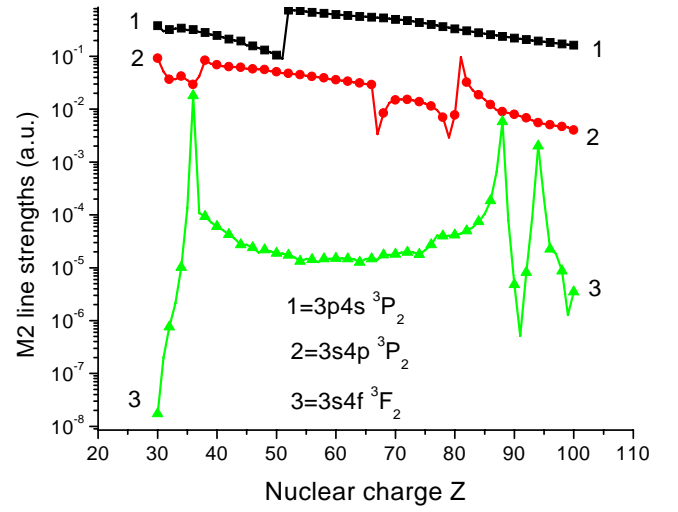
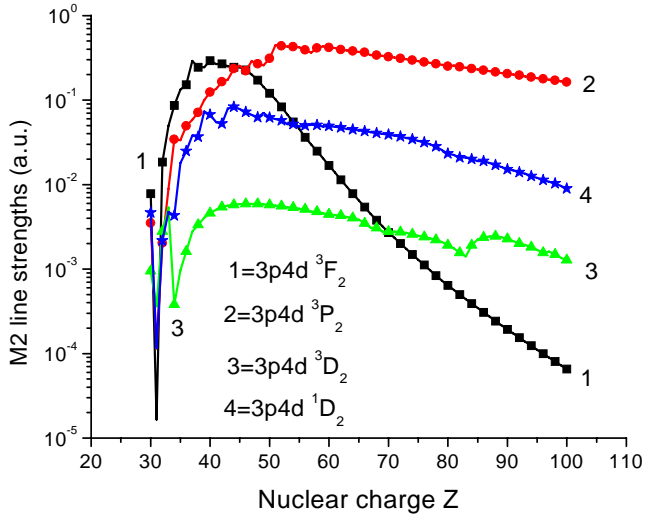
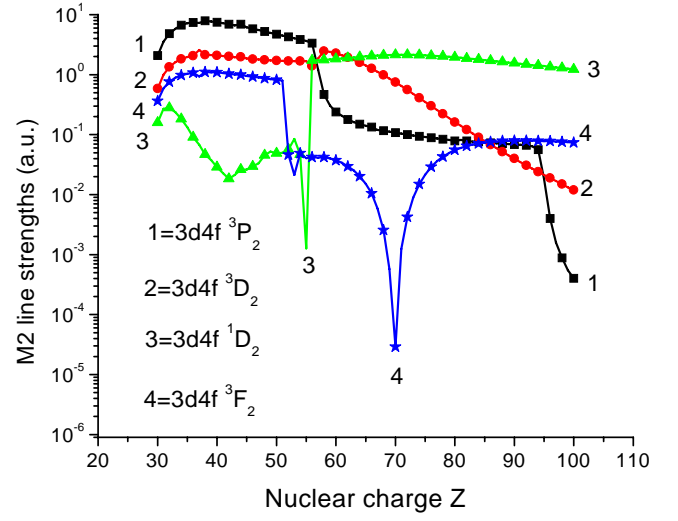
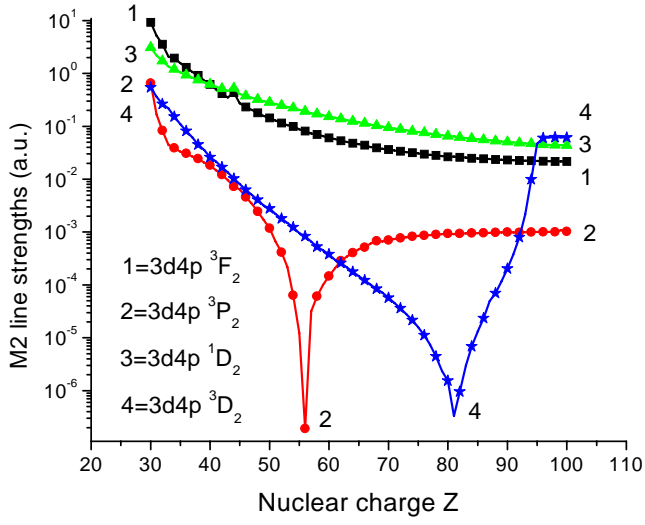


FIG. 13: M2 line strengths between odd-parity states with  $J = 2$  and the ground state as function of  $Z$

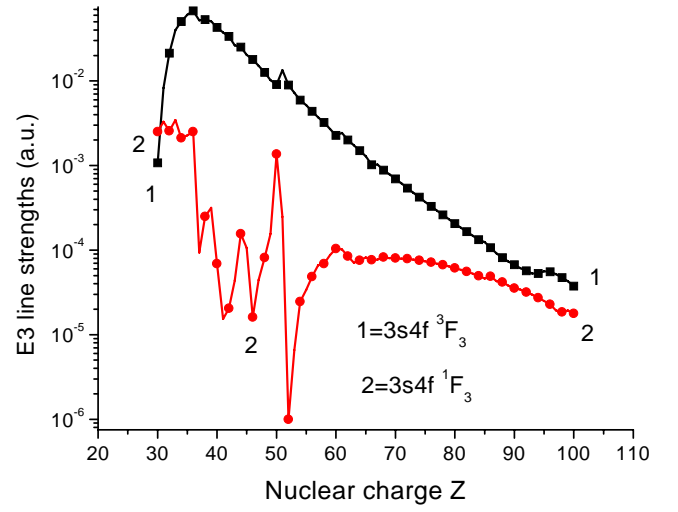
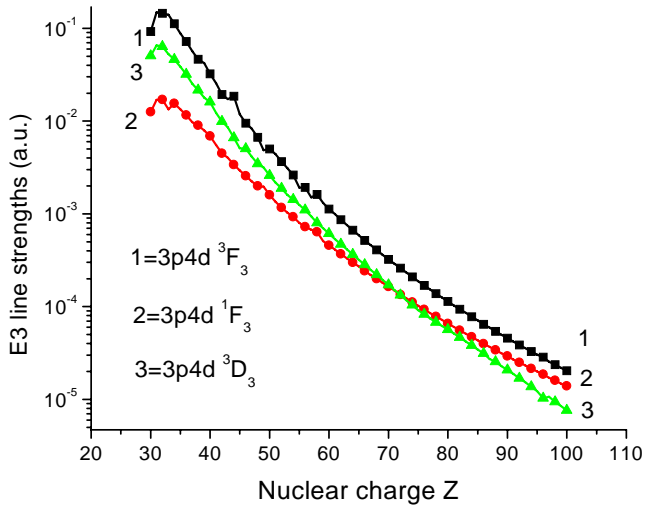
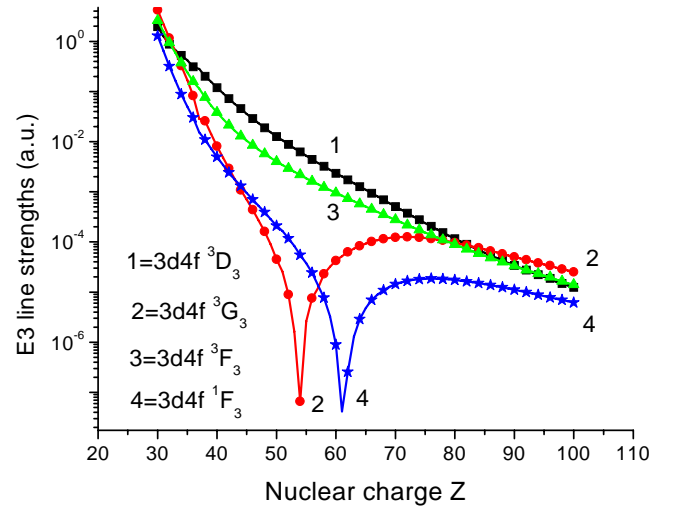
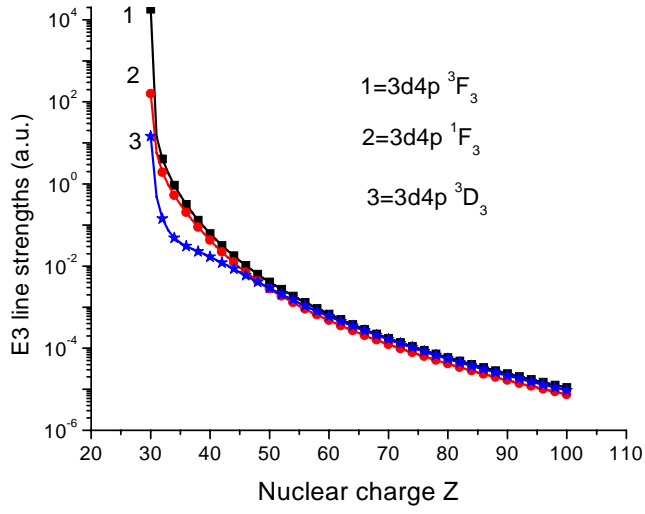


FIG. 14: E3 line strengths between odd-parity states with  $J = 3$  and the ground state as function of  $Z$

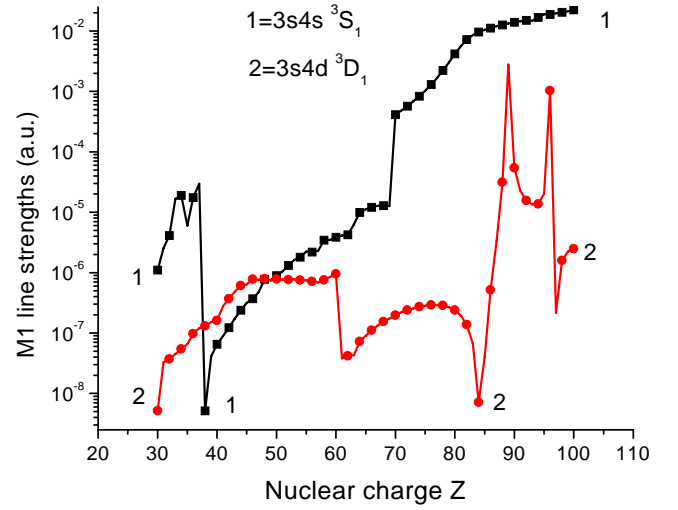
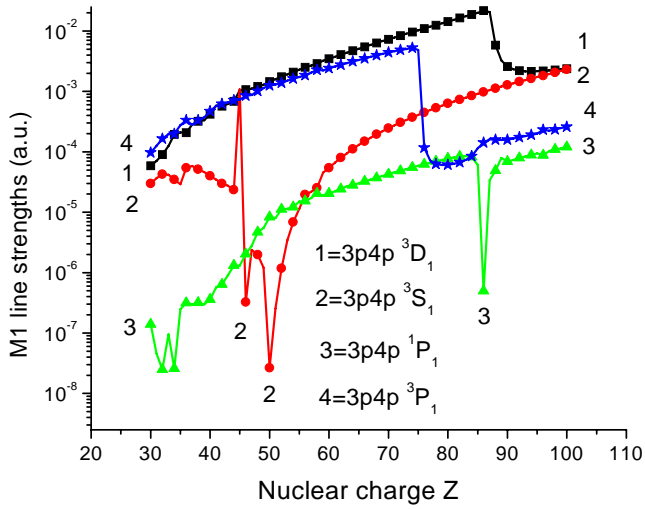
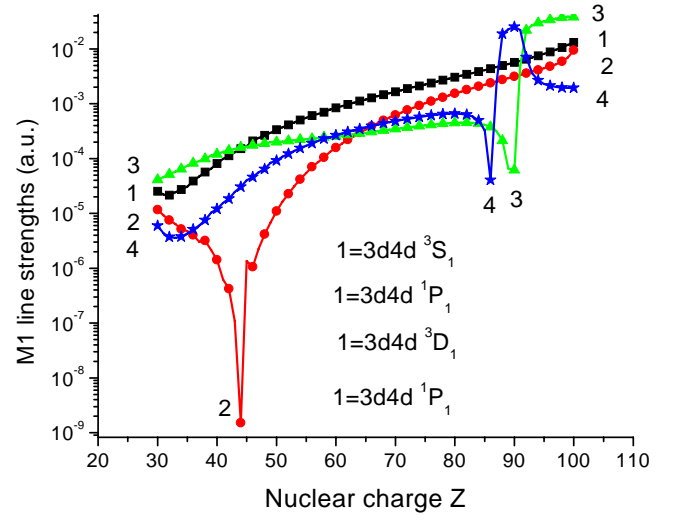
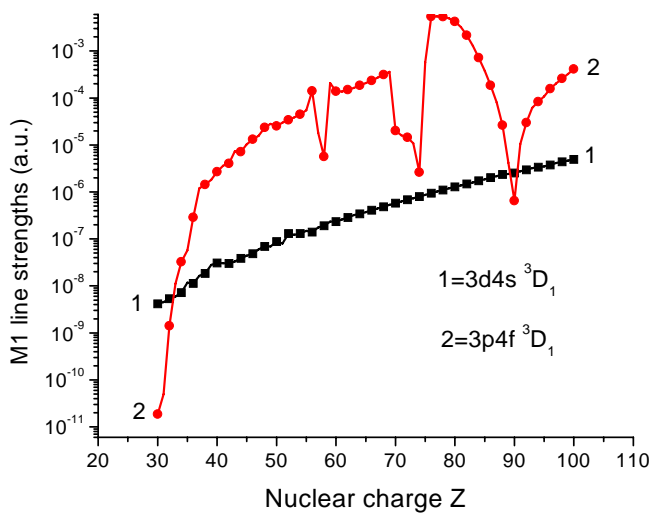


FIG. 15: M1 line strengths between even-parity states with  $J = 1$  and the ground state as function of  $Z$

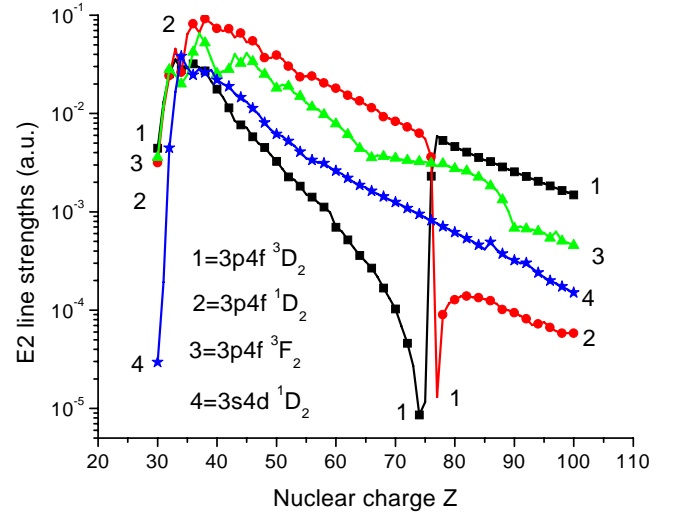
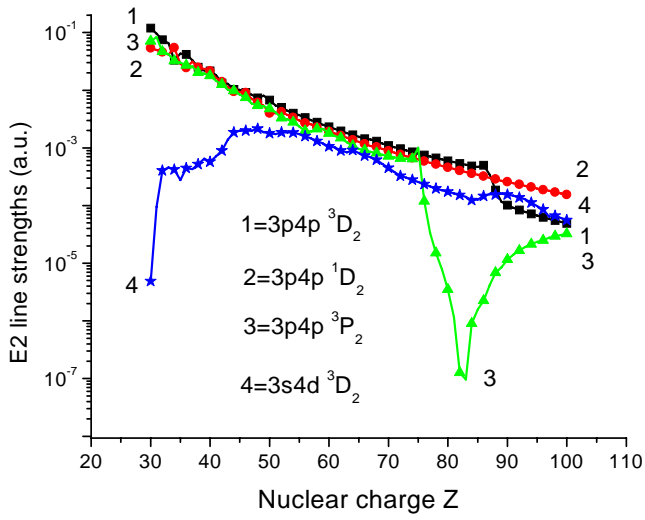
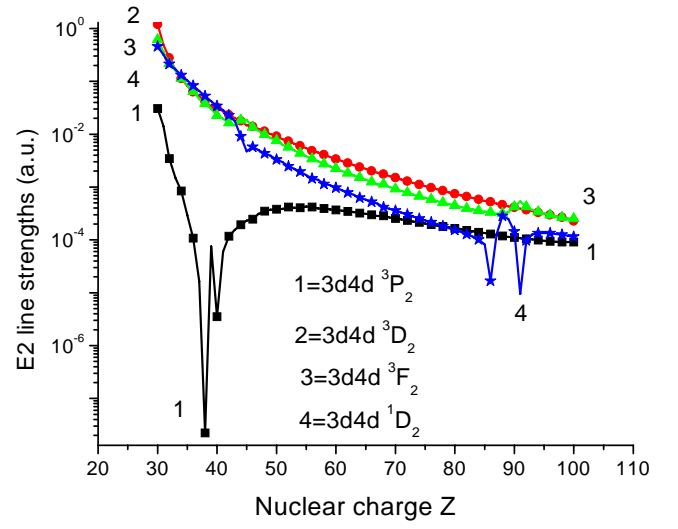
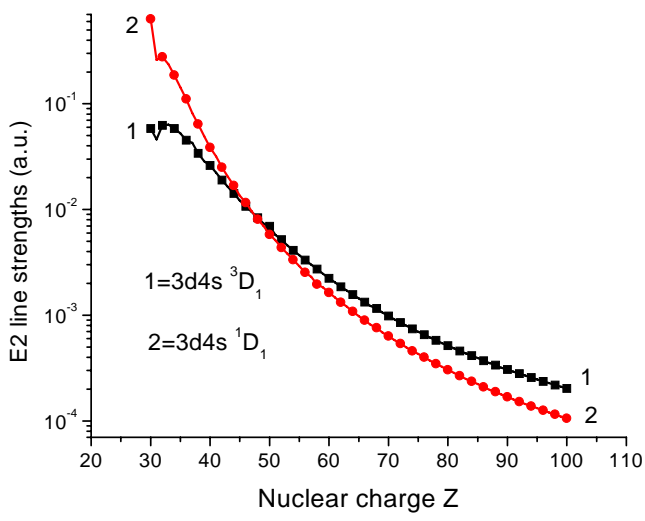


FIG. 16: E2 line strengths between even-parity states with  $J = 2$  and the ground state as function of  $Z$

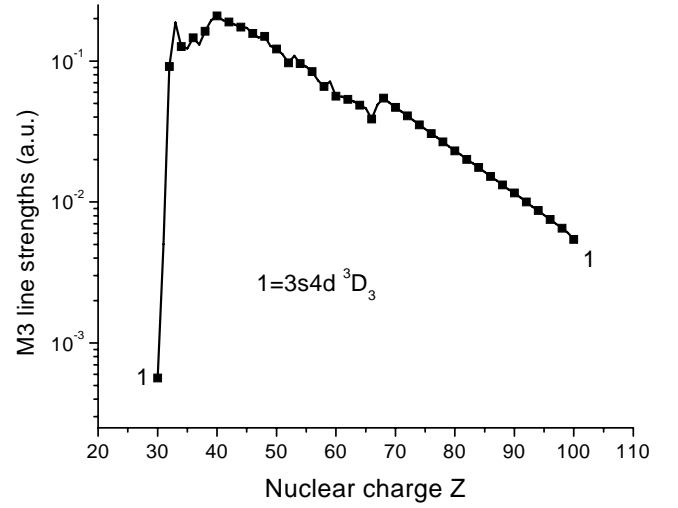
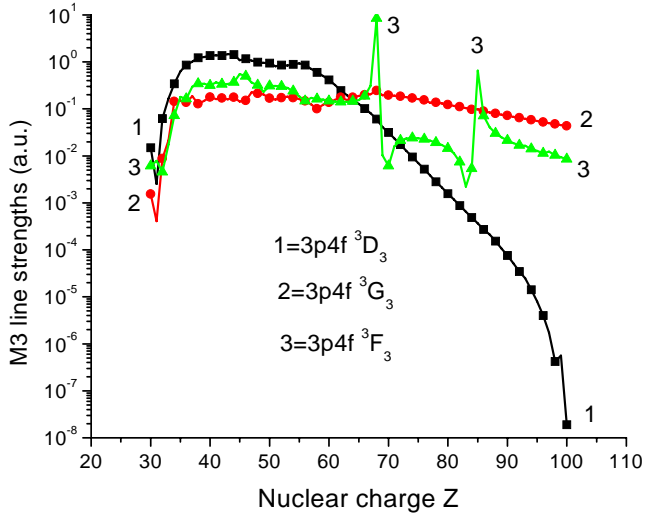
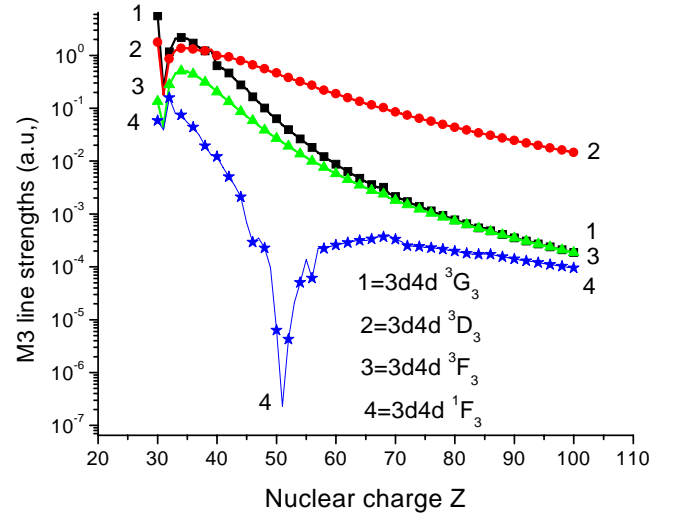
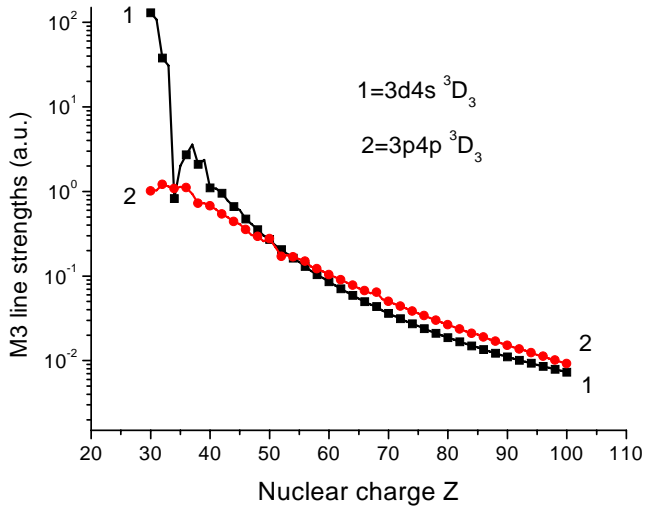


FIG. 17: M3 line strengths between even-parity states with  $J = 3$  and the ground state as function of  $Z$

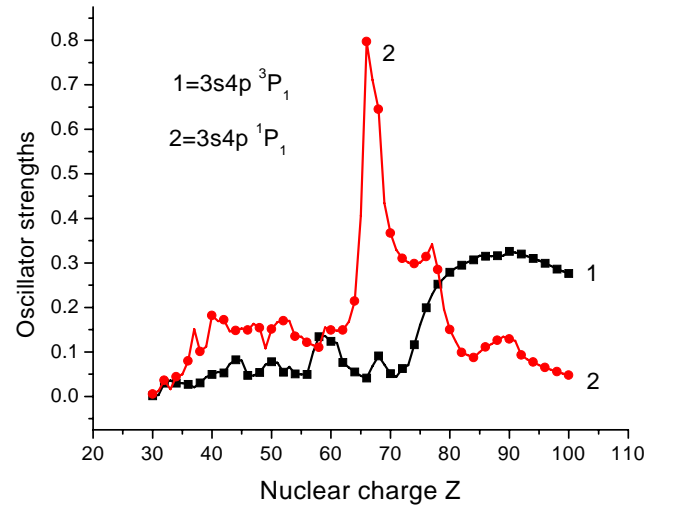
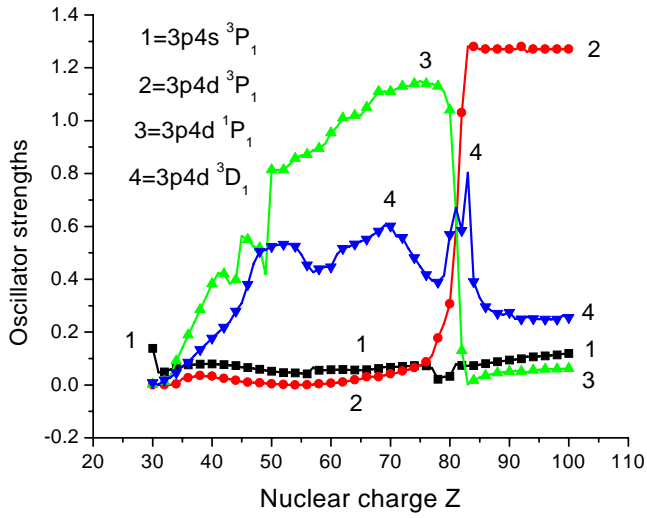
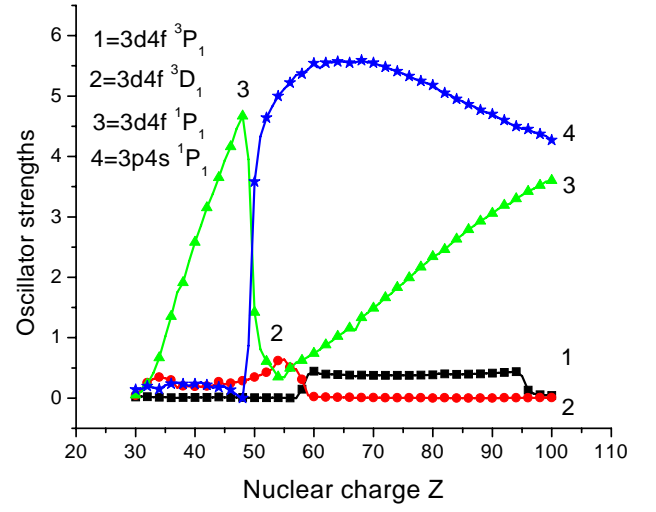
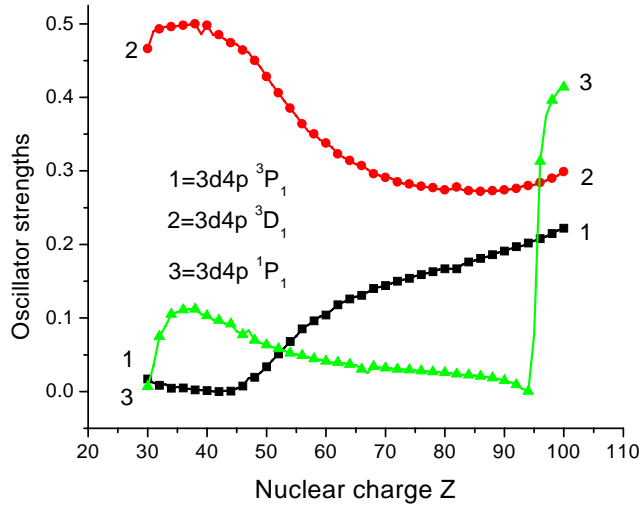


FIG. 18: Oscillator strengths between odd-parity states with  $J = 1$  and the ground state as function of  $Z$

